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DISCOVERY

A Monthly Popular Journal of Knowledge

Vol. XII. No. 137. MAY, 1931. PRICE 1s. NET

THE NEW STONECHAT FROM WEST AFRICA

(See page 137)

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Notes of the Month.

The successful demonstration last month of a new "ultra short wave" radio equipment marks an advance of the utmost importance in the field of wireless communication. Conversations were exchanged between Dover and Calais on a wavelength of only eighteen centimetres, using aerials of less than an inch in length, with a power of half a watt—which is just sufficient to light an ordinary flash lamp bulb. In the new apparatus, the sound of the speaker's voice at the transmitting station is carried to a "micro-radion" tube where waves known as "micro-rays" are generated; the waves oscillate at a rate of sixteen hundred million times a second. After concentration by an ingenious combination of two reflectors into a fine pencil of rays, somewhat similar to the rays sent out by a searchlight, the waves are transmitted into space. An important feature of the micro-rays is that they are not subject to the "fading" effects encountered in ordinary wireless transmission, and they are not absorbed by rain or fog as is the case with light rays. The demonstration has shown that wavelengths of between ten and a hundred centimetres can be used for commercial transmission. This advance is regarded as highly important, for the experts point out that, even if the transmitters were made to differ in wavelength to the same degree as is now necessary with ordinary wireless transmitters, nearly a quarter of a million micro-ray instruments could be worked without any one of them interfering with another. After the telephone conversations, a facsimile telegraph system was demonstrated by the new method. Pages of printed text fed into the facsimile machine at Calais were reproduced at a speed of one page per minute at Dover, thus representing a considerable advance on the speed of existing telegraph systems. The new development is described by an expert on another page, and a photograph of the apparatus is reproduced.

* * * * *

The possibilities of the micro-ray are not confined to the field of wireless communication. Its use will materially extend the utility of lighthouses, especially when the visibility is poor; it is at such times that lighthouses are at present least effective. For maintaining secret communication between aircraft and the land and between the ships of a fleet at sea the ray also offers fruitful possibilities, while in the field of television its use should permit developments which were not possibile when the transmission of pictures required so much space in the ether. Further refinements are being carried out to prepare the ray for every-day commercial application. Incidentally, it is interesting to recall that exactly forty years ago the first submarine telephone cable between England and France was laid on almost the same route as that traversed by the micro-ray at the recent demonstration.

* * * * *

The Society for the Protection of Ancient Relics, a semi-official body in China which is recognized by the Nanking Government, is renewing its disturbing activities against non-Chinese scientists. It may be recalled that, shortly after its formation, this body seriously hampered the work of the American expedition to Mongolia three years ago under Dr. Roy Chapman Andrews; indeed, in the following year, owing to the delay in negotiating a *modus vivendi*, the opportunity for the season's work was lost and on that occasion the expedition had to be abandoned. It appears that the object of the Society's present opposition is Sir Aurel Stein, whom it would expel from Chinese Turkestan, where he is now carrying on excavations. The reasons advanced for the demand are Sir Aurel's alleged political intrigue against the new China and his intention to smuggle antiquities

out of the country. It would be ridiculous to regard these charges as in need of refutation if it were not for the fact that in China any accusation which is calculated to inflame public opinion—especially against the foreigner—is serious. Quite apart from outside expeditions, such as that of Dr. Andrews and Sir Aurel Stein, the work carried out in China in certain branches of science—geology, palaeontology, and archaeology in particular,—of which the vital importance is becoming apparent, is dependent upon the co-operation of Europeans and Americans even in the matter of finance. The policy of the closed door now would be disastrous, especially for China.

* * * * *

The need for stronger financial assistance in archaeological work is illustrated by two appeals recently issued. Excavation of the British pre-Roman settlement at Colchester is to be continued, advantage being taken of the conditions of work on the new by-pass road before June. There should be no neglect of this exceptional opportunity to examine a site bearing on a phase of early British culture about which there is at present all too little information. The results already obtained, of which we hope shortly to publish an account, promise an ample return for further support. The second appeal is for sufficient funds to complete the excavation of the lake village at Meare, Somerset, and to enable the results to be published. Meare and the adjacent lake village at Glastonbury have together been under excavation for no less than thirty-nine years. The death of Lord Winterstoke, a staunch supporter of the work for many years, has left the local committee in financial difficulties with the end of its labours in sight. The work at Glastonbury has proved of incalculable value for the light it has thrown on the life and culture of the Iron Age in Western Europe, and the evidence from Meare is likely to prove even more illuminating when the points in which its culture differs from that of Glastonbury have been fully elucidated.

* * * * *

In last month's issue of *Discovery* an expert described the latest developments in the design of mine rescue apparatus. A new invention is now announced from the Safety in Mines Research Board laboratories at Sheffield, by means of which it may be possible to replace the existing hand lamps by an adequate supply of electric light. The new invention is a safety cable which is likely to remove the present restriction on the use of electric light at the coal face. It may not be generally realized that the amount of light used in mines is approximately one-twentieth of that available in factories, and a large proportion of the accidents underground are a result of the inadequate hand lamps at present in use. In a recent Press interview, the Director of the laboratories at Sheffield explained that a further important outcome of the new invention would undoubtedly be the abolition of nystagmus, the eye complaint which is painfully prevalent among miners.

* * * * *

An electrical musical device, which is capable of chiming more loudly than the largest bells in existence but whose notes can be toned down to the tinkle of a boudoir clock, is the latest development in mechanical music. The instrument is known as the electric "carillon" and consists of a series of small steel chimes not unlike those of a household clock. The chimes are struck by electric hammers, actuated by a keyboard similar to that of a piano. The inventor, who regards "electric harmony" as the music of the future, explains that sounds hitherto unknown will be possible by means of the new device; indeed, he goes so far as to predict that such music will require a new group of great composers "able to utilize the capabilities of emotional expression contained in electric music"!

* * * * *

There is no surer means of achieving international goodwill and understanding than by personal intercourse with the people of other countries, and on another page we review some of the latest developments in foreign travel facilities. Every year increasing numbers of holiday makers take advantage of the facilities available, and at a time when thoughts are turning to summer holidays the new series of broadcast talks entitled "The World and Ourselves" is particularly appropriate. By bringing to the microphone representatives of a number of European countries whose history and outlook are not generally familiar, the B.B.C. is doing its part in furthering international understanding. Six countries have been selected—Finland, Sweden, Bulgaria, Holland, Spain, and Czechoslovakia, and each is to be considered first in an introductory talk and later in a discussion in which a representative of the country will take part. The countries in this series have been more or less profoundly affected by the war, and it is to the problems and aspirations of the post-war period that attention will mainly be given.

* * * * *

An ingenious method of counting bees by wireless has been devized in America. A microphone is placed in the entrance to the hive, and as the bees pass over it the movement of their feet generates a current which, when amplified, operates a counting device.

New Birds from West Africa.

By David A. Bannerman, M.A., F.R.S.E.

As announced in DISCOVERY *for April, a new collection of West African birds contains several species hitherto unknown. The new discoveries raise many interesting problems and are likely to throw valuable light on the past distribution of bird life in Africa, about which there is still much to learn.*

IN reviewing the ornithological discoveries which have taken place in Africa during the last ten years, one fact stands out above all others, namely, that it is invariably in the mountain ranges, on isolated peaks, or on islands off the mainland which can boast the highest altitude, that the most sensational discoveries have been made. The recent investigation of the Uluguru highlands in Tanganyika, the great range of mountains which separates Nigeria from Cameroon, and the exploration of the Aïr Massif in the Southern Sahara, have brought to light many remarkable birds. Of even greater importance than the discovery of new species and sub-species has been the light shed on problems of ecology and distribution, bound up so closely as these are with the past geological history of Africa.

Famous African mountains, such as Cameroon Peak and Mounts Elgon, Ruwenzori and Kilimanjaro have yielded many of their secrets, and although much still remains to be done before we can claim that our knowledge of their plant and bird life is anything like complete, we already know a great deal about them; and of the first three, at any rate, we can write with considerable knowledge of their bird life. In comparison with East Africa, West Africa has attracted little attention in the past from ornithologists. Thanks to the enterprise of our Colonial Office and the Governments of the four West African Colonies in publishing an official history of the birds of the whole of West Africa, that state of things is fast changing, and ornithological interest is becoming focussed on the vast area which lies between the Senegal and the Congo.

Active Investigation.

Exploration of the bird life of the Colonies and of those of our neighbours is now being actively carried out, and in 1929 the British Museum sent Mr. Willoughby P. Lowe, an experienced naturalist and collector, to investigate the birds of the Gambia, when much valuable information was gained. Gambia is a country of extreme importance to ornithologists as being the type of locality from which many of our West African birds were first described. But in this, the smallest of the West African Colonies, there are no mountains, and although many species were added to the known list of Gambian birds, it was not to be expected that any new species would be discovered.

Studying the Map.

Although little remains to be learned in Gambia, however, the same cannot be said of our other possessions on the coast. It needed but a glance at a contour map of Africa to indicate the centre upon which efforts should next be focussed, for high above all other heights in West Africa, except, of course, Cameroon Peak, rose an apparently isolated mountain, namely, Nimba. This mountain, or as it subsequently proved, cluster of peaks, is rarely seen marked on the map. It lies in the angle made by the boundaries of French Guinea, Liberia and the Ivory Coast, at the south-east corner of the first named. Its altitude appears never to have been determined and few Europeans have seen it even from a distance. Botanists have for long speculated as to its flora, but little reliable information concerning it could be gleaned.

The surrounding country was visited recently by an entomologist, Mr. C. L. Collenette, who approached the mountain from the east and procured the unique photograph which appears on another page. Owing to the impenetrable nature of the surrounding bush, and the fact that the higher slopes appeared to be covered with grass rather than a "montane" vegetation, no attempt was then made to reach the summit. It was decided, therefore, to include Nimba in the programme of exploration. Following the sound axiom that we should investigate the fauna of our own Colonies before those of our neighbours, attention was next turned to Sierra Leone, for the bird life of that colony was most imperfectly known.

Further study of the map indicated a mountainous country along much of the eastern boundary, culminating in Bintumane Peak, the highest mountain in Sierra Leone, with an altitude of 6,450 feet. South of the Loma Mountains—the group in which this

high peak was situated—lay yet another mountain mass, the Tingi Mountains culminating in Birwa Peak, at a height of 6,100 feet. Having decided that this region promised to yield the best results, the authorities of the British Museum were fortunate in being able to secure the services of Mr. G. L. Bates, a well-known naturalist and collector whose whole life has been devoted to the study of birds at his home in Cameroon. It was agreed that he should remain in Sierra Leone for six months, and on completion of his work for the British Museum, he could put into practice his long cherished wish of visiting the Nimba Mountains in French Guinea.

Mr. Bates sailed from England in January, 1930, and thanks to the interest which the Governor, Sir Joseph Byrne, and the Colonial Government took in the project, every facility was granted. Space will not permit more than a passing reference to the topography of Sierra Leone, for it is the intention of this article to describe the discoveries which the expedition brought to light; and, as already hinted, the most interesting finds were made in the highest altitudes.

A NEW STONECHAT.

This beautiful bird was discovered on the slopes of Bintumane Mountain. The drawing shows the rugged nature of its home.

The more we study the bird life of Africa the more apparent does it become that the birds are dependent for their distribution on the vegetation belts, which in most cases stretch uninterruptedly from east to west of the continent. Breaks in distribution occur when the land rises above four thousand feet, but changes in the level of the country beneath that altitude have little effect on the bird species inhabiting the belts, more particularly if the altitudinal change has been gradual. In the area under consideration four of these conditions exist: the Sudanese arid or thorn-scrub savanna, the tree-savanna or grass woodland, the forest, and the mountains. It follows, therefore, that bird life in Sierra Leone and the adjoining countries should be rich in species.

The northern railway took the explorer through country which nowhere rose more than five hundred feet above the sea. From the windows of the train which carried him through this part of the country he observed swarms of locusts which were so dense that the very ground appeared to rise into the air when the swarm took wing—a reminder of the difficulties which beset the planter in this part of the world.

At Kamasigi, the first collecting place, at an altitude of seven hundred feet, many birds from the drier belts of the north were secured, as, for instance, the Abyssinian roller, grey hornbill, vinaceous dove, Vieillot's barbet and numerous Passerine species, whose normal habitat is in the thorn scrub of the Sudanese arid belt. Mingled with these were other of the normal inhabitants of the grass-woodland. In the gallery forests which extended into this woodland belt along the margins of streams, true forest birds had pushed their way, and it was here that Bates made the first of his discoveries which were to link some of the rarer birds of Sierra Leone with those of both the Gold Coast and the Cameroons.

The beautiful voice of the blue-shouldered robin chat early betrayed its presence to one so familiar with it in its forest home hundreds of miles to the east. The robin chat, a species about the size of the British wheatear, is smart in appearance, with a white band down either side of its black head, olive back, blue shoulder patches and bright orange-rufous underparts. It is one of those birds which give the lie direct to the oft-repeated adage that birds in tropical Africa have no voice. This species was formerly known to occur as far west as the Gold Coast; its discovery in Sierra Leone extends its range considerably. In the same forests another member of the family was procured, coloured very much as the last bird but with the entire crown white. This was the white-headed robin chat, a very beautiful bird which, unlike the blue-shouldered species, ranges right across Africa to the Nile.

Travelling in a north-easterly direction the explorer eventually reached Kaballa. The ground had been steadily rising and the bird life gradually changing. It was while in camp near this spot that the wonderfully garbed and equally rare emerald starling was first encountered. Hitherto this starling, not in the least resembling the bird which haunts our housetops in England, has been looked upon as a very rare bird indeed, and few examples are to be found in museums. It was known to occur in Fouta Jalon and turned up again recently in the interior of the Ivory Coast, but here in the high rough country of north-eastern Sierra Leone and the adjoining French territory it was found to be quite common.

Curiously enough, it is the sole representative in the neighbourhood of this widespread family, for metallic plumaged starlings of one species or another are known to most travellers in tropical Africa. The plumage of this gem of African birds is unbelievably beautiful; the whole of the under-surface as well as the breast is a brilliant golden-green as also are the wings and tail, while a band of rich purple passes from behind the eye down the sides of the neck; the rest of the underparts which are not golden-green are of the same metallic violet as the neck-band. It is not a large bird, smaller and more slender in build than the British starling and with a longer tail. As it flies and perches high up, it is a difficult bird to procure.

From Kaballa the mountains near the eastern frontier can be clearly seen. The highest is Bintumane Peak, which rises to a height of 6,450 feet; the base of this mountain is covered with real forest which creeps up the ravines halfway to the summit. No great discoveries were made in these forests, which were found to be inhabited by the normal forest birds. In this we were much disappointed, as the greatest finds in Cameroon had been in isolated patches of forest. In the damp atmosphere prevailing in those high altitudes, saturating everything with moisture, grew curiously twisted and gnarled trees hung with moss and lichen. The trees harboured equally curious birds, differing specifically and sub-specifically from known species; one, in fact, even necessitated the creation of a new genus, so striking were the characters exhibited.

Naturally, after such an experience in Cameroon, we had hoped for much from the forest-clad mountains of Sierra Leone. That our hopes were not realized is due, Bates explains, to the different nature of their growth, the trees being continuous with the forest below and not, as in Cameroon, lying in isolated patches. The higher slopes of Bintumane Mountain are covered with grass, but the summit is bare and rocky. Owing to the arduous nature of the climb and to the fact that both the ascent and descent had to be made on the same day, little collecting was done; in fact, only two different kinds of birds were obtained, both inhabiting the bare summit and both proving to be of great interest.

The most remarkable was a delightful little stonechat in its livery of black, rufous-chestnut and white, of which a drawing is reproduced. It proved on closer acquaintance to be a small dark race of the stonechat which inhabits the mountains of Cameroon. Living, as it does, entirely isolated, wrapt almost continuously in mist, with its nearest relative almost fifteen hundred miles distant, it is not surprising that it has become differentiated. Upon this little bird, which was eventually found to inhabit the summits of all the three high mountains ascended—Bintumane, Birwa and Nimba, the name *Saxicola torquata nebularum* has been bestowed by its discoverer. The other bird procured, the seven-striped rock-bunting did not, like the stonechat, prove to be new, but its presence on this mountain was most unexpected, although it is a common inhabitant of the Sudanese arid belt.

THE PICATHARTES.

This species inhabits the mountains of Sierra Leone and the Gold Coast, and is described as the most remarkable bird in West Africa. This and the previous drawing were specially prepared for *Discovery*.

Leaving Bintumane behind and trekking to the eastern boundary of the Protectorate,

the explorer passed over the roughest country it had ever been his bad fortune to cross, " traversing the steep and winding paths almost every step was on bare rock and scarcely any two on the same level " he wrote in a letter to me. The name of this region is Tembikunda, and it is near here that the great river Niger has its source. This district proved fruitful for birds and two weavers were discovered : the golden-capped weaver and the dusky twin-spot which had never been previously recorded from west of Cameroon.

Then followed a two hundred miles' journey eastwards through French territory to Mount Nimba, before returning once more to Sierra Leone. But first a word must be said about the Picathartes, probably the most remarkable bird in the whole of West Africa. We had hoped that it might be encountered somewhere on the route, for although the home of this actual species is unknown, an allied species lives in Cameroon, in a very similar environment to that just described, a broken country of rocks and cliffs entirely covered by forest. Curiously enough, only the second specimen known from west of the Gold Coast reached the British Museum during Bates' absence in Africa, the bird having been shot in Sierra Leone in the Sugarloaf forest of the Peninsula a number of years previously.

Looking at this bird, named misleadingly the white-necked bald crow, one's mind instinctively reverts to prehistoric times, for, to put it mildly, the Picathartes is a most extraordinary looking object. Its head is as naked as an orange, and the skin which covers it is apparently all red or yellow, except for the hind portion which is black. Not a feather or hair is present on its bald pate ; the neck is covered with creamy-white feathers, the upper part of the body being grey ; the wings which are very short and rounded, and the tail which is long and graduated, are brown, and the entire under-surface of the body is creamy-white.

A Curious Bird.

Many curious features are connected with this bird, among which are the heavy bill with nostrils in the middle and the powerful legs and feet. Anatomists are still undecided as to its correct position in the Avian tree, but Dr. Percy Lowe, our leading authority on the classification of birds, assures me that it has nothing whatever to do with the Corvidae, and that if anything its affinities are with the starlings. We shall know more about it when Dr. Lowe has completed his anatomical investigations. Until a specimen was secured in Sierra Leone it was known only from the Gold Coast, although a close ally with a grey neck and the bare skin of the head blue, black and carmine is known to live in the most inaccessible parts of Cameroon.

Parrots of Sierra Leone.

From the eastern frontier of Sierra Leone to Mount Nimba is a journey of two hundred miles. Bates' route followed the boundary line as far south as Kailahun and thence east close to the northern Liberian border. Here an old friend, in a slightly different dress, was encountered for the first time—the familiar grey parrot, but not the race which has in the past been imported in such numbers into this country. The species which inhabits Sierra Leone and Liberia is a much darker grey bird than its neighbour, which extends from the Gold Coast right across the Great Equatorial Forest to Uganda, and rejoices in the name *Psittacus erithacus timneh*. The discovery in the Gulf of Guinea twenty-two years ago of a third race of the grey parrot in the islands Principe and Fernando Po, opens up yet another subject upon which much could be written if space permitted—the effect of environment on island forms, a subject upon which A. R. Wallace discoursed so delightfully in his classic, " Island Life."

Bates' journey through this extreme south-eastern part of French Guinea, though made with the definite object of reaching Mount Nimba, proved highly fruitful, for many rare and interesting birds were encountered along the route, which by a less experienced naturalist would have gone unnoticed. The finding of the rare black dwarf hornbill and the discovery of a new race of yet another Cameroon species in the white-breasted thrush-babbler must have gladdened the heart of the collector as he neared his goal, not to mention the re-discovery of Swainson's olive-bearded bulbul. This is a dully-coloured little bird about the size of a red-breast with olive-green body and a bright yellow throat, concerning which nothing had been heard or seen for sixty years. Large hornbills, the most conspicuous of which was the giant yellow-casque hornbill with its huge, hollow casque surmounting the bill, were occasionally observed in these forests. This bird makes such an astonishing noise as it beats its great wings that in the Ivory Coast it is locally known as the train bird, its flight sounding in the distance like a heavy train under way.

Even when Nimba was reached his luck did not desert him. A bird shot at the foot of the mountain augured well for what lay ahead, for it proved to be a fine new bush-lark, the darkest race of all the *Mirafra africana* association.

The ascent of Nimba was made in company with a French officer. The highest point, known as the Dent du Prism, was in Bates' opinion an unclimbable rock—probably the highest peak in all West Africa after Cameroon Mountain. The little stonechat already found on Bintumane was again discovered on Nimba, but the greatest prize from near the summit of this mountain was a fine new race of Richard's pipit, the darkest ever discovered. This bird forms yet another striking link between the Cameroon avifauna and that of the mountains already discussed, for although many forms of Richard's pipit have been described from various parts of Africa, Cameroon Mountain is the nearest point from which one had previously been known; and that is some fourteen hundred miles distant! On the whole, Nimba proved disappointing; had the wonderful forests of Liberia extended unbrokenly to its summit, how different would have been the results achieved! Forest certainly lay round it, or rather covered the lower slopes of the mountains, which form, not as we had formerly believed, a single peak, but as Bates' diaries and Collenette's sketches prove, a group of three, rising abruptly from the surrounding plains.

A VIEW OF MOUNT NIMBA.

One of the highest peaks in West Africa, Mount Nimba was the centre of Mr. Bates' activities in French Guinea. The photograph shows the mountain viewed from the east.

Of the birds encountered on the journey back to British territory nothing need be said, but this account of the remarkable discoveries cannot end without mention of one more mountain mass not included in the itinerary we drew up before the collector left England. These heights, which bear the name of the Tingi Mountains, are situated in the Konno district of Sierra Leone. The highest elevation is named Birwa Peak and it seems that its altitude, 6,100 feet, has only recently been ascertained by a survey party. It is, in fact, almost as high as Bintumane Peak, and situated as it is not more than thirty-five miles to the south-east, the one can be clearly seen from the other. Birwa must rank in importance from an ornithological point of view with both the other mountains described for on its slopes, or upon the grassy plateau 4,500 feet up, where Bates spent two arduous weeks, all the new birds which he had discovered on the other mountains were found, besides a new grass warbler of the family *Cisticola* concerning which a whole volume has just appeared.

Finally was secured the greatest prize of all—the tiny new wren-warbler. This is not a geographical race, as the others had proved to be, but an entirely new species which has been christened *Prinia leontica*: a wee mite of a bird with a tail almost as long as its body. In these days of intensive collecting it is seldom indeed that ten new sub-species are discovered, let alone a bird worthy of specific rank. The discovery of this little bird, flitting among the tree ferns and the upper growth of the wooded ravines, was a fitting climax to a successful exploration of this little-known part of British territory. It must be borne in mind that the country here described so cursorily had never previously been entered by an ornithologist, and that the nature of the journey precluded elaborate field observations being made. The longest period spent at any one place was two weeks, and that is not sufficient for much to be learned of the life history of even the commoner species; much less can we expect to discover the habits of such rarities as have been described in this article.

Of the lessons to be learned from the collections this is not the place to write, but we may pause to reflect how these birds became isolated on these peaks when their nearest relatives are separated by tens of hundreds of miles of intervening "bush." It will give food for thought to many, and if the new discoveries help to shed light on the difficult problems of past distribution of bird life in Africa, the making of this collection will have been justified. To take life merely for the sake of amassing specimens in museums, as we might collect postage stamps, is unjustifiable and utterly to be deplored. Bates has given us the data; it is now up to us to see that this valuable material is not wasted.

Digging for Dinosaurs.

By F. W. H. Migeod, F.R.G.S., F.R.A.I.
Leader of the British Museum East Africa Expedition.

Recent exploration of dinosaur beds in East Africa has resulted in many important discoveries, among which is the skeleton of a reptile whose appearance resembles that of a gigantic giraffe. Work has now ceased owing to lack of funds, but the author shows that continued exploration would be amply justified.

In the ages of the world known as the Jurassic and the Cretaceous the land was peopled by reptiles. It is hard for us human beings to recognize that all that had gone before in the fields of creation and evolution had no other destiny than to be the disregarded setting of almost brainless lizards. Yet so it was; and many millions of years had to elapse before the Creative Force recognized that what it had done so far might be improved upon. Then mammals with their larger brains entered in. Increasing in size to almost unwieldy proportions, the greater lizards came to an end.

East African Remains.

In many parts of the world these greater lizards, the dinosaurs, have left their bones. In East Africa their remains have so far only been found at Tendaguru, fifty miles north-west of the port of Lindi in Tanganyika, and in Nyasaland on the north-west shores of the lake. For some years, since 1924, the British Museum East Africa Expedition has worked the deposits at Tendaguru, but during the last year, for the first time, it has added to its exploratory work the deposits in Nyasaland. The exposed dinosaur beds in the neighbourhood of Tendaguru Hill cover some two hundred square miles. There are three layers separated by two marine beds, the upper known as the Trigonia Smeei zone and the lower as the Nerinea zone; and there is a remnant of a third, the Trigonia Schwarzi zone, eight hundred feet high on the top of Tendaguru Hill. Although there are these intervening evidences of the encroachment and recession of the sea, there seems to be no evidence that the dinosaurs are of radically different types. How far the marine beds, therefore, indicate complete submergence of the country, and how far merely intrusions by means of creeks, is not yet fully ascertained. The latter is probably the view that has most to support it.

In previous years I worked the top deposits. During the last season I confined myself to the second in the area known as Kindope, from a stream of that name. The lowest is yet unworked by the British Museum. The Germans, who maintained a big expedition in the field before the war, made great discoveries in both the uppermost and second layers, and studied the lowest to some extent. It was near where the Germans found their celebrated kentrurosaurus, a horned dinosaur related to the stegosaurus, that the British Museum expedition last season discovered a large dinosaur, which is perhaps allied to the brachiosaurus. I marked out a small area the previous year (when the grass was burnt) for intensive examination, and the result was the discovery this season after about a fortnight's work of the skeleton, the site of which is recorded as M 23.

The two marine beds between which M 23 lay, the Trigonia Smeei and the Nerinea, are about a hundred feet apart vertically, and the skeleton lay somewhat nearer the upper bed than the lower, its altitude being 472 feet above sea level. The rock on which it lay was a grey clay like the Kimmeridge and containing boulders of the same material. Above were alternating red and grey clays in thin layers. When viewed in a vertical wall the layers were seen to be in a waving line. A fault was visible crossing the ground a little below the ventral side of the skeleton. From its position it might be assumed that the carcase came to rest in the backwater of a river. It partly sank in the mud and the upper and exposed side must have been somewhat rapidly buried by intermittently running water.

The Site of "M 23."

It is probable that the "Kimmeridge" clay had been partly exposed when this dinosaur of presumably Jurassic Age settled down in it, and the surface was swept by currents of water bearing alternately scoured-out Kimmeridge and brown clay from near by. The brown clay subsequently formed a thick deposit over all, and it is on this brown clay that the upper marine bed directly lies.

The carcase lay on its right side and the extremities are missing. All parts of the skeleton, too, are not

equally well preserved; the roots of present-day trees have done some damage, principally at the sacral region. In one place there was a damp layer, so that while the highest and lowest bones were hard, the intermediate section was powdery. A strong and corroding impregnation of iron here and there had in addition done some considerable damage. As to the general appearance of the dinosaur, it might be said that it was giraffe-like in shape but on a far larger scale. Being a reptile, it would have had a hide like a lizard's. Presumably it was cold blooded; although whether the dinosaurs were actually so is a point that has been debated. At the shoulder it must have stood eighteen feet high, with its neck towering over twenty feet higher. At its hind quarters it was not more than twelve feet high, and a moderately long tail tapering away behind would give a total length of perhaps seventy feet. The tail was presumably not so long as that of the diplodocus or brontosaurus, which carried their necks horizontally and were lower at the shoulder than at the hind quarters.

Some remarks must now be made about the bones. Of the skull no fragments have so far been identified, and thus the most interesting part of the body, as is so commonly the case with the dinosaurs, is lost. But a large tooth was found measuring $6\frac{1}{2}$ inches in length with a maximum circumference of $5\frac{3}{4}$ inches; this would indicate that the head was large. The tooth is pointed and has a slightly serrated inner edge. Two small teeth were also found in other places. Their dissimilarity in size would not be unusual if the dinosaur were a theropod, the flesh-eating kind, which had teeth of very varying sizes; but it is rather disconcerting in this case, the presumption being that the reptile was a sauropod, the vegetation-eating kind.

Comparing the vertebral column with that of the diplodocus in the Natural History Museum at South Kensington, the most striking feature is the far greater size of the lower neck vertebrae. On the other hand, the posterior dorsal vertebrae are somewhat smaller. Owing to some damage at the sacral region, it was not possible in the early stages of excavation to decide which was the last sacral vertebra so as to number the dorsal vertebrae therefrom. In default the shoulder vertebra had to be taken, and contrary to expectations it showed distinctive difference. This vertebra, which measures 24 inches in length, became the zero, and nine neck vertebrae were found leaving perhaps five more to complete the neck.

The first cervical, C 1, is 33 inches long, compared with about two feet in diplodocus. Running its full length and connecting with preceding and succeeding vertebrae is a great superstructure. This is built up of "girders," plates and "buttresses," giving great strength for very little weight, and stands 44 inches high. The longest cervical actually is C 3 which is 41 inches in length; and thereafter the size diminishes. A considerable number of short neck ribs were lying near the lower cervicals. In addition was the discovery of a number of neck tendons of great length. One of them, extending backwards from C 5, measures $97\frac{1}{2}$ inches and is completely ossified and fossilized. It is about an eighth of an inch in diameter throughout its entire length and has an elongated triangular head ten inches long with a terminal width of six inches.

Coming back to the shoulder vertebra, the first dorsal was no more than fourteen inches in length, and the centra of the remainder measured from eleven to nine inches till the sacrum was reached. Most of the centra were firmly fixed into each other, and although to outward appearance solid, they are of very light internal construction, the cellular spaces being filled with the different coloured clays in which the skeleton lay. The neural spines were of great length especially on the anterior dorsals, on which they leaned forward to allow for the elevation of the fore part of the body. On the more anterior vertebrae

THE SITE OF THE GIRAFFE-LIKE REPTILE.

The digging party at Tendaguru where the skeleton of the giraffe-like creature was unearthed. The exposed dinosaur beds in this neighbourhood cover about two hundred square miles.

*

the spines spread themselves into "wings." Of the tail only a part was excavated intact, but three small stray vertebrae were found later.

In most cases it has been found at Tendaguru that the limb bones are in evidence, while the rest of the body is scattered or broken up. M 23 was quite an exception, and while the spinal column was intact the limbs had suffered. The best find among them, in very good condition, was the left scapula. It had shifted to the end of the line of the neck vertebrae and lay on a natural curve. The coracoid was completely fused and the total length measured on the curve was 87 inches. It measured 26 inches across the arm and shaft, and the end, which was splayed, was 27 inches across. Of the right scapula there was no trace. The humeri were 57½ inches long and 20 inches maximum width. The femur was about four feet long, but owing to damage its exact length could not be ascertained. An ischium and parts of a pubis were found, and the right ilium was intact.

DIGGING IN MWAKA SYUNGUTI VALLEY.

Four sites were explored in the Mwaka Syunguti Valley, the object being to ascertain how nearly related the dinosaurs of this region were to those discovered at Tendaguru.

It was unfortunate that the sacral region and the last dorsal vertebrae were somewhat damaged, as it is here that was located the large expansion of the spinal cord which may be three or four times the size of the head brain, and formed a sort of second brain. Its functions and relation to the anterior brain afford an interesting subject of speculation.

A last note to be made on this skeleton relates to the ribs. Lying on its right side it is only to be expected that the left ribs, which would be uppermost, should be broken and carried away by intermittently flowing water. The right side ribs, however, were pressed down into the mud, and there they lay until with decomposition the whole flank became separated and the muscles joining the ribs to the vertebrae came apart. Their distance down is about four feet at the breast, and this figure doubled gives some idea of the thickness of the body of the living dinosaur. One of the heaviest ribs measured eighty-two inches, but a thinner one was over ninety-two inches long. The former had a somewhat triangular section, and another big rib lying under the breast was flat and had a width of about six inches.

The time came to carry out the other part of the season's programme, which was to examine the dinosaur beds of Nyasaland. I therefore covered up the bones I had not had time to remove and left them until I returned in November. Mr. F. R. Parrington, of the Cambridge Museum of Zoology, who had been lent to the expedition, had gone on in advance from Lindi early in August, by lorry to Songea, and thence on foot to Manda on Lake Nyasa, taking most of the stores. I followed at the end of the month, and joined him at Manda with a day to spare before the steamer arrived. Between Songea and Manda a botanical collection was made at Likuyu about three thousand feet above sea level, and some surface bones, part of a dicynodon, were collected at Munya Maji.

The north-west shore of Lake Nyasa is remarkable for the fact that within a few miles of each other collections of bones can be made from such diverse beds as Karroo, Dinosaurian (Jurassic and Cretaceous), Pliocene and Pleistocene. Hitherto only small surface collections had been made by geologists studying the country from the point of view of minerals. The two months' work there, however, shows that the possibilities of the ground are great. It was the dinosaur beds with which the expedition was principally concerned, as it was desired to ascertain how nearly related the dinosaurs of Nyasaland were to those of Tendaguru. Although these beds extend as much as seventy-eight miles north and south, they are only a very thin line, and the point selected to work at was up the Mwaka Syunguti valley in the foothills of the Nyika Plateau.

After a few days spent in a preliminary examination of this very broken valley, digging began and four sites were explored. Site A was about a mile straight up the valley from the small village where the camp was situated. It was on a hill top, and excavation was easy as it was only necessary to throw the earth

down the hillside. Here a number of bones were laid bare. They belonged to at least two individuals and most were in good condition. Among them was a scapula measuring forty-five inches by seventeen inches, a radius, a pair of sternal plates, parts of ribs and a pubis and ischium, besides some vertebrae, mostly the centra only.

Site B was about a mile farther up the valley. Only a few bones were found here and they were scattered as much as ten yards apart. They were on the surface or immediately below it, and digging did not reveal other bones in proximity to them. The finds were a humerus of thirty-two inches; a femur, forty-six inches long, the centra of two caudal vertebrae, and another of extremely small size. In addition were some small fragments of bones about a millimetre in diameter, two shells (*Unio sp.*), and part of a big bone completely calcified. Site C lay towards the east side of the valley and about the same distance from the camp as A. The finds included a femur, a tibia, a meta tarsal, a sacral vertebra and several centra; and, what was most interesting in this association, a vertebra with a neural spine which was cup-like. Site D was another hill peak only about a hundred yards from A. It produced a group of bones all belonging to a single small sauropod. On the surface of the ground close by, amongst the coarse quartz gravel which covers the surface of nearly all the valley, were found several pieces of fossil wood which were probably of derived origin. Most of the limb bones were found, and there were a few vertebrae with their spines complete. To give some idea of the size of the reptile it may be mentioned that the femur measured 34 inches and the humeri 27 inches.

It is early yet to state definitely the connexion of the Nyasaland dinosaurs with those of Tendaguru. There are species of gigantosaurus common to both

VERTEBRA OF "M 23."

In the foreground is a cervical vertebra of the reptile "M23," which is thirty-three inches long. It was divided up and the parts were set in plaster.

SCAPULA OF A DINOSAUR.

This unusual photograph is not a mountain scene but the scapula of a dinosaur. It was left lying on a mound after excavation until it could be set in plaster.

localities and others will undoubtedly be recognized. One salient feature, however, is that all the bones hitherto found are very much smaller than those of the gigantic animals so common to Tendaguru. Incidentally, when it was seen that fossil bones had a value, one enterprising native down the valley made a collection of all he could find on his farm and putting them in his house offered to sell them to me. He received sixpence for his report; but a sale was not effected. Outside the foot-hills and rising out of the alluvial plain is Uraha Hill, 250 feet high. It constitutes one of the best exposures of the Pliocene beds, on the top being a thin Pleistocene deposit. Some collecting was done here on the slopes of the hill and it is well worth a detailed examination.

The last part of the work of the expedition in Nyasaland was on the Karroo deposit south of the conspicuous Mount Waller. Close by are hot sulphur springs and coal. The Chiweta beds, so-called from the village below them, are about half a mile from the lake shore, rising to some two hundred feet, and cover not more than a square mile. The ground is mostly a very hard shale and difficult to break up, and the dip being northerly to north-east, the oldest reptilian remains are on the south-west side. Surface finds of varying value were made over the whole ground, dicynodon bones—chiefly parts of skulls—being most in evidence, and the skull of a labyrinthodont has also been identified. At the beginning of November work had to cease, and I took the monthly steamer back across the Lake to return the same way as I had come, to Tendaguru, where the last remaining bones of M 23, which have been left covered up, were taken out, and the site further dug over. The visit to Nyasaland was little more than a preliminary reconnaissance, but it proved that further digging there would be amply justified. This is not likely to be done in the immediate future for the same reason that work at Tendaguru has been stopped. Funds are lacking.

Progress in Shipbuilding Research.

By G. S. Baker, M.I.N.A.

William Froude Laboratory, Teddington.

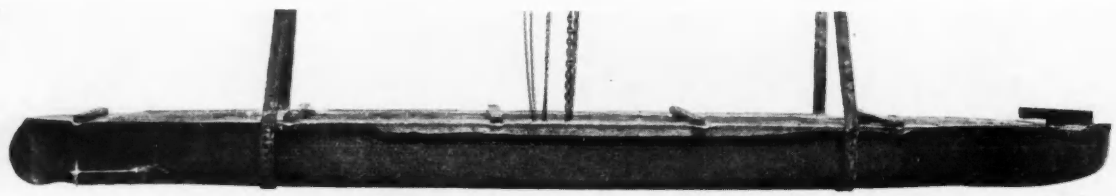
The growing demand for practical tests in shipbuilding research has necessitated extensions to the work being carried on at the National Physical Laboratory, and a new tank is to be erected at a cost of £45,000.

THE subject of ship resistance has engaged the attention of many scientists for a long time. Newton produced a form of "least resistance" which is more resistful than many others. Euler, Romme and Chaplin attacked the problem, the last two experimentally. But their work is largely useless since, like Newton, they did not really recognize the intrinsic problem, nor did they know how to apply the results of any model tests. It remained for the late William Froude to give the connecting links between model and ship. Froude was not content with the mere enunciation of these laws, but built a long water basin in his own garden at Torquay, in which he made a number of tests and demonstrated the use of his methods.

Fortunately the Naval Construction Department of the day was alive to the importance of his preliminary work, and the Admiralty soon engaged him to carry on his researches on naval ships. To this end a tank for testing ships of the Royal Navy was built at Haslar, and the obvious advantages accruing from this work lead Mr. A. F. Yarrow in 1909 to offer £20,000 to defray the cost of an establishment where similar work might be carried out for the Mercantile Marine. In this way, the Yarrow Tank of the William Froude Laboratory came into being. The tank was completed in 1911, and during the period which elapsed between this and the outbreak of war in 1914 had established itself as a definite unit in the shipping industry.

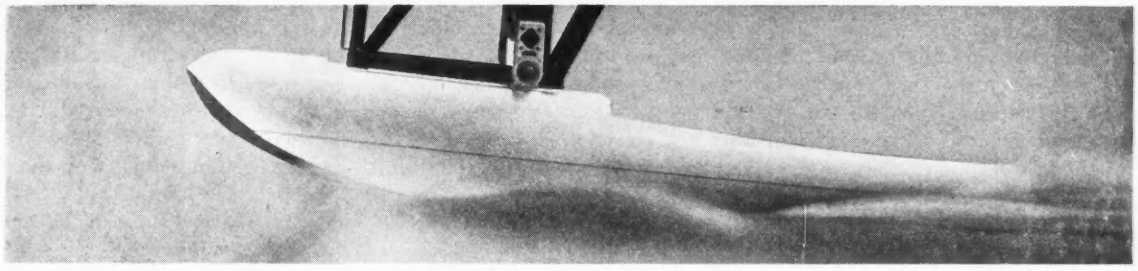
The real functions of the tank can best be described by quoting from one of Yarrow's letters: "The carrying out of research work which would indicate the direction for possible advances in naval architecture, and for experimental investigations of a confidential character which private firms may desire, and for which they would pay suitable fees." I have been told by Sir Alfred Yarrow, that he was finally moved to the course he took by the fact that in Great Britain he could not at that time get any tests on the efficiency of the forms of the ships he was building, and was compelled to go to Germany; that when the tests were completed there was nothing to pay, but rather he was thanked, as it enabled them to keep pace with our progress. Great Britain has always lead the world in shipbuilding and ship-owning, and the tank was built to help maintain this position. But with the passage of time, one tank has become inadequate for the needs of the industry and expansion is required in several directions.

Perhaps this will become clearer by considering the work done. Broadly, this consists in making any ship as efficient as its service conditions will allow. Efficiency here is meant to cover propulsion, steering and general seaworthiness. Any shipbuilder or owner may send the design of his ship to the Laboratory, where a model is made exactly similar to the proposed ship as regards all underwater features. The model is equipped with special apparatus of various kinds, having regard to the particular feature under test. When it is ready it is put into the tank and either towed or propelled down the tank by its own screws.



WAX MODEL OF A LINER READY FOR TESTING.

Any builder may send the design of a proposed ship to the laboratory where a model is made in wax. A propeller and motor are fitted to the model and it is then towed or propelled by its own screws down the tank. Measurements are made of the hull resistance, speed, thrust obtained from the propellers and other features under test.



HULL OF A FLYING BOAT UNDER TEST.

It has become increasingly difficult to cope with the growing demand for every kind of test. Until recently the form and propulsion of flying boats was the subject of considerable research, but this has largely been abandoned under the pressure of mercantile work. The new tank will enable this branch of investigation to be revived.

The models are quite large, varying in length from 15 to 25 feet, the tank in which they are tested being about 550 feet long, 30 feet wide, and 12 feet deep. In the course of a run down the tank, measurements are made of the hull resistance, its speed, the thrust obtained from its propellers and the power which must be put into the propeller to obtain the thrust.

In other tests the forces on the rudder when this is put over and the ability of the rudder to steer the ship are obtained. Waves of all types can be created in the tank, varying from the low persistent ground swell, which sometimes promotes a degree of pitching or rolling quite out of proportion to its wave height, to the short steep breaking waves which at their best are mere "white horses," the silver and green of our seascapes. The waves take a great deal of power out of the ship, and it has been found that by model tests this wastage can be reduced. In addition, the liability to damage of the bottom from the violence of the blows received can be greatly reduced by suitable shaping of the hull.

The average onlooker watching a ship proceeding to sea does not, perhaps, appreciate the fact that in its progress an enormous amount of energy is being expended without any noticeable sign. Yet the propellers of a destroyer at its top speed are exerting a force of about eighty tons upon the water, and the propeller of an ordinary coastal tramp must thrust with a force of six to seven tons to maintain a speed of ten knots. The possibility of waste is large, and such waste can be detected by model tests.

The Yarrow tank has now been at work for twenty years, and during this period about two thousand ship hulls have been tested while a mass of data and experienced has been gathered. During this period a number of researches have been completed and the results have been published. The theoretical laws of wave resistance have been investigated, and empirical formulae for determining ship speeds which give bad wave resistance have been formulated. The effects of form and dimensions on frictional and total resistance of all types from a plank to a sphere, and from a dredger to an express liner, have been methodically determined. The work carried out with propellers lead to the general use of what is now known as "aerofoil" blade propellers and to the adoption on many single screw ships of what is known as a "fin"; this is a simple device at the stern which adds considerably to the efficiency of the screw.

The study of seaworthiness has been carried out partly by experiments with models in waves and partly by sending several members of the staff to sea on a variety of ships. These trips have been made during the winter with proper measuring apparatus, and by this means ship and model data have been co-ordinated and the broad effects of certain features on "cleanness" of hull and amplitude of pitch have been determined. During the past year the results of a research on the air resistance of the hull and superstructure of a ship was published by the tank, showing the large amount of power which can be lost from this cause and how it varies with different classes of ships. This is being continued with the object of finding method for reducing it. A still more recent research is that dealing with our coaster vessels. These are of rather abnormal proportions, having relatively more beam than an ocean-going vessel. A paper dealing with the effect of form of hull on their resistance was read by Dr. Todd at the meetings of the Institution of Naval Architects in March. With all this data, the tank staff is able to advise the designers as to any fault in their ship and how to set about eliminating it. This has been one of its most important functions during this last ten years, and has been the prime cause of expanding the test work.

At first sight it might appear that an experienced designer or owner would learn from a few tests the best form of hull, propeller or rudder for his ship and that no further work of this kind would be required.

But on closer examination, the large number of disconnected variables becomes obvious, and one can never afford to lose sight of the fact that the profit of a ship depends upon the narrow margin by which the earnings exceed the expenses, and not on the total cost of running the ship. These margins are small, and can easily be lost by faulty design and not making the fullest use of scientific discovery. Any man who to-day builds a ship with a steam turbine or oil engine of only ten years ago, or who shapes the hull or propeller of a single screw ship as he did ten years ago, is foredoomed to failure, so quick and widespread is the march of progress. Progress has been made in the design of almost every type of ship.

In the early part of last year a paper was read by the Staff of the Laboratory showing how the resistance of the ordinary dumb barge as used on the Thames could be reduced by one half. The majority of barge builders are still content, however, to build the old resistful types although they cannot afford to do so, and are bound to sink in the economic struggle for existence unless they change their methods before their continental competitors do so. At the other end of the scale one may take some liners which have now been in service for several years. The first two of these were costing several thousand pounds every year in repair bills; the last two have cost only a few pounds. Their shape was altered after tests had been made in the tank which showed the defects of their original form. Very few vessels of this type are now built without at least a test of the propulsive efficiency, but even with these ships the owners are content in many cases to "trust to experience" as regards the steering and stressing of the rudder. In the last four years 114 ship designs of all kinds have been tested, and considerable economies have been effected. The latest figures show the extent to which the tank has assisted the shipping industry. It has been estimated that work in the tank during the past four years represents an average saving to the industry of well over £100,000 each year.

Varied Research.

There are many other directions in which the tank serves the shipbuilder and owner. Paddle steamers, for instance, present a special problem of their own. They must move at all speeds, but the wheel must maintain a certain immersion if it is to be efficient. Its exact position fore, aft and vertically can be determined on a model, and the *Eagle* class so well known on the Thames is a fine example of our work in this direction. These facts have slowly but surely become obvious to the industry. The inevitable result has been that, despite the working of an extra shift of men and the giving up of time which should have been devoted to research, it has been difficult and sometimes impossible to cope with the demand for tests even in the three lean years which have just passed. Until a few years ago, considerable research work connected with the form and propulsion of flying boats was carried out. This has had to be abandoned under the imperative pressure of mercantile work, and no research of this kind has been done for the last two or three years.

The Question of Cost.

One great difficulty in the way of extension was the fact that additions could not be made in instalments; the whole capital cost of a new water basin or tank must be found as a first step. Early last year the position was placed before the Government by the London and Liverpool Chambers of Shipping, who proposed that another tank should be built so that test work could be carried out without material delay. The suggestion was so well supported by Sir F. E. Smith of the Department of Scientific and Industrial Research that funds for the purpose were made available by the Government. The extension of the offices is now in progress, and the contract for the construction of the tank has just been placed. The new tank will be considerably longer than the Yarrow tank, its length being 684 feet, but the cross section of the basin will be smaller. The length will permit acceleration up to at least thirty feet per second, the maintainance of this speed for some two hundred feet run, and a quick retardation; special braking gear has been developed for this purpose.

This tank will be completed and able to carry out test work about June, 1932, and with the exception of one difficulty should be able to cope with the demands of the industry for some years to come. The outstanding problem includes cavitation, cascading and racing. For their study a special tank in which the pressure can be lowered considerably is necessary. These evils are very real and show themselves in a variety of ships. One of the most recent is the *Bremen* on which the renewal of propellers due to this defect must cost the owners at least £10,000 per year, apart from incidental costs such as lost time. There is a strong probability that this matter will arise in connexion with the new liners of which so much is expected, and I hope to see this branch of research taken up in the near future. Then, the ship-owner will have within this country facilities at hand and an experienced staff to tackle every phase of ship propulsion and efficiency.

Reconstructing a City of Ancient America.

By Frans Blom.

An expedition has just returned from investigating the ruins of Uxmal, the capital of the Xiu dynasty in Mexico. The buildings will be reconstructed in full size at the forthcoming Chicago World's Fair.

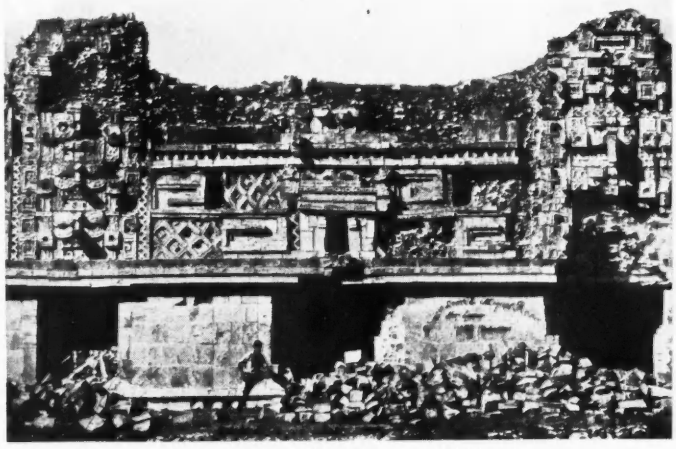
"In *Katun 2 Ahau* Uxmal was founded by Ahuitzok Tutul Xiu." This short statement in the "Books of Chilam Balam," the historical records of the Maya, announces the founding of one of the greatest and most picturesque pre-Columbian cities on the American continent. In "*Katun 2 Ahau*," or A.D. 1007, the powerful Xiu nation took possession of the site of Uxmal, and soon afterwards many smaller cities, such as Kabá, Labná and Sayil grew up in the vicinity.

Here the Xiu dynasty ruled for over four hundred years, during which their capital grew considerably. Great buildings were erected for the governor, temple was added to temple, and the Pyramid of the Dwarf, as it is called to-day, gradually grew to a height of 104 feet, casting its shadow over the Quadrangle of the Nuns. No building in America surpasses the governor's palace at Uxmal in magnificence and beauty, and few can be compared with the House of the Turtles and the Quadrangle of the Nuns. The Maya architects joined hands with the sculptors, and the painters coloured the elaborate carvings on the façades.

Four centuries of development and growth ended when the Tutul Xiu led a battle for liberty against the oppressing chiefs of the neighbouring city, Mayapan. The Xiu were victorious but instead of returning to their capital they abandoned it for no apparent reason. So strongly did the Maya build, however, that the great buildings to-day loom out of the jungle in imposing majesty, and stir the imagination of the few visitors who have discovered that the ruined cities of Yucatán are as interesting and impressive, as full of mystery and charm, as those in Egypt or Greece.

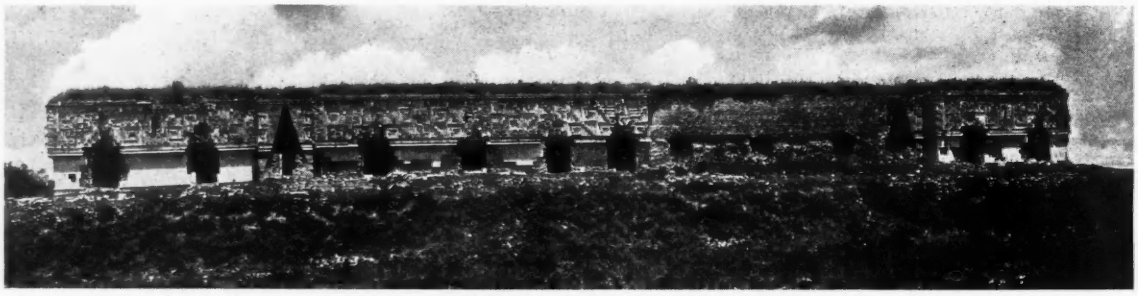
The expedition organized by Tulane University reached the ruins of Uxmal in February 1930, and took quarters in the east building of the nunnery. This was the sanctuary a thousand years ago of the nuns who tended the sacred fires in the temple at the top of the Pyramid of the Dwarf. If they allowed the fire to die out, they were rewarded by death. Our object was to measure, draw, photograph and cast all the buildings of the nunnery quadrangle in order to reproduce them in full size and restore them to their ancient grandeur at the Chicago World's Fair of 1933. There they will be housed in the lecture and exhibition halls of the anthropological section of the Fair. In the course of our work at Uxmal we became intimate with the more subtle beauties of Maya architecture, and acquainted ourselves with many refinements and details which escape the casual visitor.

The nunnery rises on a great terrace, which is reached by a broad stairway now crumbled to a slope. In the centre of the south building of the quadrangle is a great Maya "arch," really a corbelled vault, as the Maya did not know the true arch. Doors open both north and south and the frieze above them is decorated with imitations of small Indian palm-thatched houses, crowned by grotesque faces of gods. Passing through the entrance arch, it is clear that its walls and slopes were at one time covered with a coat of stucco, on the



LIMESTONE DECORATIONS ON THE NUNNERY.

Detail of the elaborately carved limestone decorations on the north building of the nunnery. The carving will be reproduced when the buildings are shown at the Chicago World's Fair.



THE HOUSE OF THE GOVERNOR.

The architecture of the Xiu dynasty is at its best in the House of the Governor at Uxmal, which is described as the most beautiful building in pre-Columbian America.

fragments of which one can still trace the faint outlines of a fresco painting. Suddenly one halts before one of the many puzzles not peculiar to Uxmal but common in many other Maya cities. High up on the slope of the vault, and directly on the carved stone of the wall, are a number of imprints of human hands. They are in red paint and were originally covered by the stucco coating on which the fresco was painted. Students of the Maya have long been acquainted with these imprints but no one has yet been able to explain them.

Entering the court of the nunnery, the east building with its attractive lattice-work façade lies to the right, and to the left is the west building, decorated with the intertwined bodies of feathered serpents. This building is in an advanced state of ruin and has long intrigued explorers. Through a most careful study, we hope to reconstruct the façade—and our reconstruction will probably be much disputed.

The north side of the court faces the entrance, and the north building rests on a terrace twenty feet high. A splendid stairway leads up to it and on either side on the court level stand two small temples in a sad state of ruin. Search as we might, we were not able to find what type of ornamentation covered the façades of these buildings. Therefore we chose the front of another building at Uxmal, the exquisite and simple House of the Turtles for these structures. At the World's Fair, the stairway will be flanked with two reproductions of the temple.

At the foot of the stairway to the north building lay three fragments of a monument, its surface carved with hieroglyphics. During our search for the steps of the stairway we found several more fragments, and to our great delight were able to assemble them, thereby reconstructing a most important piece of historical data. Piece by piece the fragments were gathered up and fitted together. Cement was used to bind them, and now the visitor will see the monument restored to its original appearance. This labour took many weeks, but was worth it.

The north stairway leads to the most elaborate of the buildings in the nunnery group. This structure is over 260 feet long, and eleven doors face the square. At its two ends are other doorways, leading to small twin-roomed apartments. Over the doorways rise fantastic mask-topped panels, alternating with imitations of small native palm houses, which are crowned with undulating bodies of double-headed serpents.

In 1588 Father Alonso Ponze visited the ruins of Uxmal. He climbed the Pyramid of the Dwarf and strolled through the many rooms of the nunnery, stopping to admire the intricate decoration of its façades. Later Father Diego López de Cogolludo wrote the history of Yucatán, using many documents which have since been lost. The story of Father Ponze's visit was told by one of his two secretaries, and this description was a great help to us in our work of reconstruction. It is Father Cogolludo who tells us that this great group of buildings was used as a nunnery.

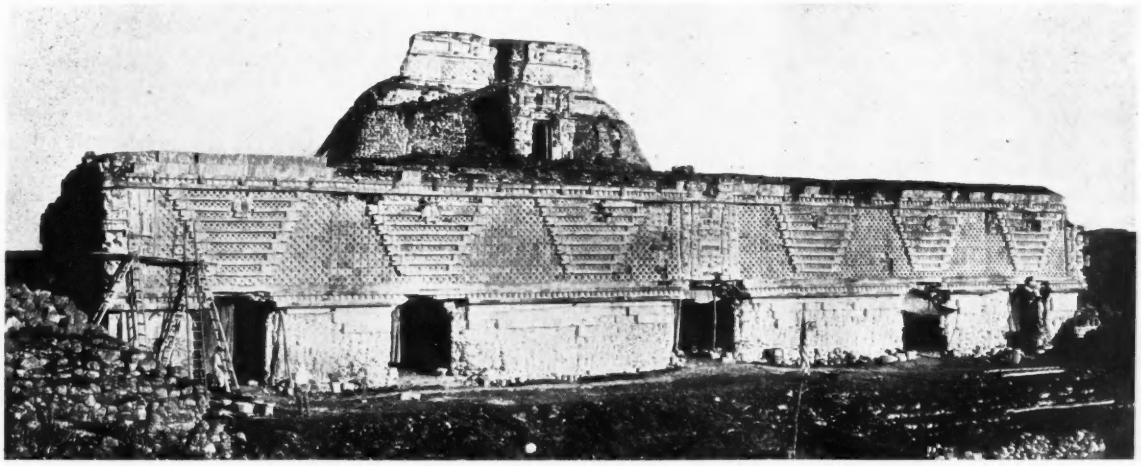
Long ago the artists and architects of Uxmal became tired of the façade on the north building. They tore it down in parts, and built a new and more splendid façade on top of the old one. To-day the building is crumbling, and in the great scars which time has made the older façade ornamentation is clearly distinguishable from the more recent. Curiously enough, the court is not rectangular. The east and west buildings are not at right angles to the north and south buildings, and the court is narrower at its northern than at its southern end. Further, the floors of the north ends of the east and west buildings are two and a half to three feet higher than at the south ends. It is clear, therefore, that the Maya architects of A.D. 1100 were perfectly familiar with the rules of false perspective.

This aroused our interest, and we later found that the elaborately carved friezes of all the buildings of the Xiu period at Uxmal are not vertical, but lean forward. They have a negative batter, to insure a more effective play of sunlight and shadow on the deeply undercut carvings. Here and there in nooks and corners, protected from the rain and the bleaching sun, are brilliant remains of the polychrome which once enhanced the splendour of the façades. Careful notes were taken of the scattered remnants of colour, and in reproducing the buildings we hope to restore not only the walls and carvings but also their excellent colours.

From the terrace of the north building of the nunnery, looking south, is a distant view of one of the most exquisite buildings of pre-Columbian America, the House of the Governor. Nowhere has Maya art or the genius of the Xiu architects produced anything to excel this edifice. From a distance we were impressed by its simplicity and grace, and a closer view revealed the beauty and intricacy of its design. The great pyramid on which the Temple of the Dwarf stands rises to the east of the nunnery to a height of 104 feet. On the east and west side stairways lead at a steep angle to its two temples. According to legend it was built over-night by a dwarf who became ruler of Uxmal, but a careful study reveals that it was built little by little. Throughout the centuries different rulers added to it, and the inspiration of many Xiu architects are expressed in its strata of growth.

The walls of the temple which crowns the Pyramid of the Dwarf are tottering to-day, and after a rainy season one of the most impressive structures of ancient America may be beyond repair, though not beyond reconstruction. To-day one can still climb to the roof of its topmost building. There we established one of our major points of triangulation, and from there we looked out over the surrounding country. Close to the part of the city which has been described and explored we saw many groups of buildings. After triangulation, they were investigated. Twenty-three groups of hitherto unexplored buildings repaid our search. Survey work showed that Uxmal covered an area five times larger than Chichén Itzá. Buildings situated on hilltops from two to five miles away also proved to belong to the culture of Uxmal.

One day Inez May, a Maya who is the government caretaker of the ruins, helped me to chop our way through the dense bush to a large rock terrace. Reaching the top of the terrace we saw some large stone slabs; one of them was unusually large. We headed towards it, stumbling in a network of vines and bramble. The side of the monolith facing us was smooth and without carving, but the opposite side was carved with the figure of a warrior or high-priest, most elaborately sculptured. We cut some of the bush and then called assistance. When the dense foliage had been cleared away there lay before us the fragments of nineteen monoliths, decorated with human figures and rows of hieroglyphics. The mere fact that we had found monolithic stelae at Uxmal was a surprise, but our amazement was doubled when we realized that the figures and lettering on the stones discovered on the rock terrace antedated all previous records of Uxmal history by five hundred years.



THE EAST BUILDING OF THE NUNNERY.

The façade of the east building bears an intricate lattice-work design. In the background are the Pyramid of the Dwarf and the Temple of the Magician.

The Nigerian as House Builder.

By J. M. B. Homfray.

District Officer, Nigeria.

Ingenious methods are employed by builders in Nigeria, where houses are constructed almost entirely of vegetable material from the neighbouring forests. The author's sketches show a typical Nigerian dwelling.

It is truly said that the African has everything at his door. This applies to house-building as much as to anything else. Almost all the houses built by the Ibo or Ibibio and nearby tribes of Nigeria are of temporary structure and are built of vegetable material. They are inhabited by both races alike, and serve as an adequate protection against the sun and rain provided that they are properly built. More permanent structures are increasing, however, although for various reasons they are not likely to become universal for many years, in fact, for centuries.

The first step is, of course, the choice of a site, and this is governed by a number of factors. The Ibo is usually a farmer or fisher, and although the hunter and canoe-maker are important members of the community, especially the latter, they form a small minority; the priests, chiefs and medicine-men have also to be considered. The casual labourers, ever increasing in number, are usually lodgers and not householders, whether they labour for the Government or for private firms. If they build houses for themselves they do so near their work. When they are lodgers they either occupy quarters built for them by their employers or pay rent to a landlord. The farmer has a share of his father's land in common with his brothers and therefore builds his house near his father's; or where farms are far away, separate farming settlements are built actually on the farm. If he is a fisher as well he may have a second house near his fishing ground. In the Niger delta the majority are both fishers and farmers, and owing to the annual flooding their houses are subject to particular modification.

The density of the tropical forest is an important factor in the choice of a site, and where the forest is very heavy the houses of a village will all be found in one clearing, perhaps half a mile in diameter. Some are very small and low and are built touching one another, while others are large and reasonably high with walls of solid mud a foot thick; they stand from fifteen to twenty yards apart and are surrounded by plantain gardens, but they are close enough to form a village. Where the forest is less dense the houses are so scattered that it is impossible to discover when one is in a village until the market place is located. This is an open space surrounded by small sheds and shady trees.

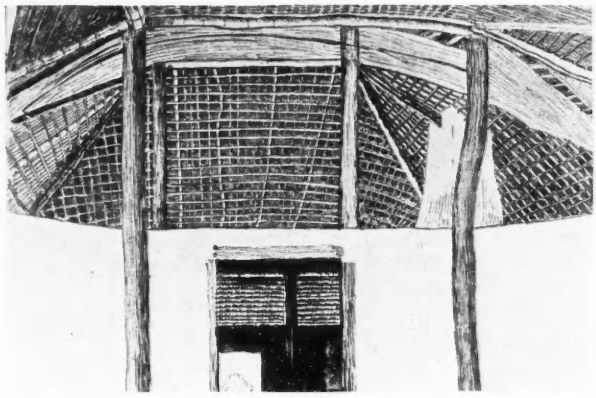
Two tribes living close together and speaking different languages are frequently found to choose their sites in quite different ways. One may occupy the same clearing in the forest generation after generation in spite of disease, while the other continually clears fresh ground and rebuilds on another site. This is usually on account of a belief that the old site was unhealthy; roofless and abandoned ruins stretch for hundreds of yards along the sides of overgrowing paths.

Some tribes live in groups of houses inside a solid mud wall of defence with a loopholed watch tower in the centre, while others build circular grass-roofed huts which are scattered about the forest or grass land. In all cases the essential parts of the building are one or more wooden supports in the centre. The framework of a square house consists of a ridge pole, while the ribs and cross-pieces of the roof are made from palm branches, bamboo, or simply poles from a local tree according to convenience. The timbers most favoured for the posts of the house are ironwood, iroko (African oak), or

A HOUSE IN NIGERIA.

Nearly all the houses built by the Ibo or Ibibio and neighbouring tribes of Nigeria are of temporary structure, but serve as an adequate protection against the sun and rain.

a split section of the fan palm stem, all of which are more or less white ant resisting. Some tribes take little pride in their work, however, and put in any timber with the result that the house quickly falls a prey to insects. The walls may either have a framework similar to the roof, or may be made without framework and consist of layer after layer of well-trodden clay from a foot to six inches thick.



AN INTERIOR VIEW.

The more important houses are roomy structures, but the majority have only one or two rooms. The illustration shows one of the more elaborate houses built for Europeans.

The framework of the walls is the same as that of the roof, but the mud is not plastered on the walls until the roof has been thatched, because it may be washed away by the rain. Very little trouble is taken to set the posts vertical, and an error of five degrees is common. It makes little difference in a small house, but when houses are built on a slope the posts are often found to be a compromise between the vertical and horizontal.

It is only in recent years that door and window frames have made their appearance, thanks to the European-trained carpenters. Doors there were and still are of original design, with pivot pins at the corners which fit into holes in the wall; they are usually made from rough-hewn timber and are elaborately carved. When the framework of the roof has been completed the surface is covered either with mats or grass thatching. The mats are made from the long leaves of the tambo palm which grows in swampy ground, and are bent double over strips of stiff fibre cut from the midrib of the same palm; they are arranged in the manner of slates or tiles. The mats are usually bought in the local market, or are made by the household and are transported either in rolls or bundles laid flat.

When the roofs are of mats quite a low pitch is sufficient to prevent the rain from soaking through; but when they are of grass the pitch has to be made very high and the thatch is nearly a foot thick. The whole of the framework is secured with what is known in pidgin English as *tie-tie*, which is fibre from certain plants. Often banana or plantain stems are used, the stem being beaten out to pulp and the fibres separating out as the result. It is rather remarkable that no nails are to be found anywhere although blacksmiths have been common in every village for generations.

The roofing mats are secured in position with tie-tie, and a framework of palm branches or light poles is spread over the exterior to prevent the wind from removing the grass or mats. The mud for the walls is obtained by digging a hole in the ground anywhere except on rock; it is mixed with water, and the red clay, which abounds in most places, is trodden until it reaches the consistency of dough. It is then carried in large lumps and plastered on the wall-frames or built up into a solid frameless wall.

The disused mudholes are found all over the place, and as they are many feet deep and wide, they form unwelcome traps for the unwary, especially when they are overgrown with plants and creepers. There is no particular art in the way in which the walls are mudded, but whether they are solid or constructed on a framework, each successive operation must be left to dry before the next is commenced. In the case of the smaller houses or more temporary structures, roofing mats are sometimes used for the walls instead of mud, while in the flooded areas it is often not worth while to put mud on the walls, and privacy is obtained simply by the use of mats. In such cases a raised mud platform is built in the house for sleeping purposes so as to escape the water, and all the valuables are placed on a platform as high as the ceiling.

The Hausas use very effective mats which are loosely woven of tough grass and thus let the air and light through. These are used for the walls of the garden as well as the house and are very neat in appearance. Hausas come from the North, and settlements are found in every important centre. Walls are not usually treated in any way, except by Europeans, who have them whitewashed both for cleanliness and purposes of light. A border of tar forms the wainscotting. The floors are often rubbed with a mixture of ashes and leaves, which forms an effective protection against insect pests. Occasionally one finds a house with ornamental patterns of black, white and red on the walls, but

this is hardly ever a private dwelling but is usually a public building of some kind. Houses are built in the first place as private dwellings, and they are never of more than one story in height except when built in imitation of European dwellings. The houses of chiefs may be as much as sixty feet long and twenty feet wide, but otherwise they are less than quarter of that size.

Single-roomed Houses.

The houses with solid walls are usually roomy, but one has to bend down to enter a house built with wattle walls. The majority have only one or two rooms, and the family sleeps on mats on the floor while the cooking is done at a fire in the middle of the room or outside in dry weather. The more important natives have what is called an *obi* house, which is practically a shrine to the family gods and ancestors. A variety of sacred relics having a magic or religious significance is kept in such dwellings. Outside the obi house the old men sit in counsel and decide weighty matters or act as judges.

Court houses, rest houses, mission schools and other large buildings are associated with the coming of the white man, and are still of one storey ; the structure is again secured without nails, and the number of rooms is never large. Market stalls are very small and low and have no walls, while some of the club houses have walls of bark instead of mats. The chief enemy of the temporary house is the white ant which, in spite of every precaution, eats its way up the poles and into the roof, consuming the mats and causing the house to leak after a very short time. The posts can be sunk in concrete or tar to insulate them, but the effect is only temporary because the termite will find a way through.

The use of Iriko rafters and beams supported on concrete pillars successfully insulates the mat roof from insects and the mats last three or four times as long in consequence, but the native is conservative in these matters and false economy is his principal. Besides white ants, other boring insects attack inferior timbers, and cause a shower of wood dust. I remember one rest house hastily constructed with mats which were too green ; it was devoured almost immediately by caterpillars and within a month it was uninhabitable.

A well-made grass thatch is nearly a foot thick and makes for a cool dry house. There is usually a lining of light-coloured mats to relieve the darkness of the high ceiling and to reflect the light downwards from the windows. The chief danger of grass houses is their liability to catch fire, when they burn with an intense heat. In the dry season the roof is just like tinder, and one naturally has to be very careful with lamps.

A native who has a number of wives or a large family usually builds his house in a court-yard surrounded by a mud wall as a protection against thieves and enemies. A man with only one or two wives has no court-yard and two rooms are usually sufficient. All the larger dwellings have shrines which house sacred objects and often include a pot containing an odd collection of old egg shells, water, mosquito larvae and other such creatures. The shells are the remains of a sacrifice of eggs and the living contents come there by chance. Incidentally, they are probably the cause of the sickness which, curiously enough, the shrine is designed to ward off. The mats used in house-building serve also as hats, umbrellas and sunshades when bent into a circle.

The stone house represents the most advanced native construction ; it is of local ironstone and is copied by native craftsmen from the European bungalows. The bush house costs about a tenth of the money required for a permanent structure of the same design and proportions, but it only lasts a few years and needs repairing every few months. At a little extra cost many improvements can be made which are economies in the long run. For instance, the roof can be insulated from the ravages of white ants by supporting it on concrete or stone pillars, iron-wood posts, or wooden pillars with a stone or concrete base two or three feet thick. The roof can be prevented from sagging, and hence leaking, by supporting the framework upon properly carpentered rafters. The mat roof can be replaced by one of corrugated iron, but iron roofs are so hot that they must have a very high pitch and there must be a ceiling to keep the house cool.

Modern Requirements.

Requirements in the tropics are so few that the houses are very simple ; a kiosk is perhaps the most desirable. This is a room with walls about eighteen inches high, and one therefore sits in the open with a roof as a protection from sun and rain. One of the great disadvantages of a bush house is its darkness, for the number of windows has to be limited otherwise the walls will be weakened. Further, the edge of the roof comes down to within about six feet of the ground, and therefore shades the windows. In this respect the kiosk has a distinct advantage, but more than one is advisable in order to avoid monotony of outlook. Insect pests remain the chief enemy of the Nigerian builder, for they lurk in every corner and attack the structure at night.

South America : (3) The Nitrate Fields of Chile.

The Chilean nitrate industry is undergoing great changes owing to the competition of the synthetic nitrogen products now being manufactured in Europe and the United States. The Editor of DISCOVERY *describes a visit to the most modern works in the country, where new methods of treating the ore are in operation.*

DRIVING sixty miles through the barren desert that stretches from the coast to the Andes, I visited the nitrate fields at Maria Elena, being the first English journalist to inspect this property, which was opened in 1927. The desert extends for thousands of square miles, and not a trace of vegetation grows in this arid region, where rain is almost unknown. The road from Tocopilla consists for the most part of a track made by the wheels of vehicles, with a sprinkling of tar in the grooves that have been formed in the sandy surface. When I add that our Chilean driver at times exceeded forty miles an hour and that twice a halt was necessary to allow the engine to cool down, it will be realized that the journey was decidedly an adventure. From the coast the road winds its way through rocky hills, making a steep ascent to the desert plateau where Maria Elena is situated, four thousand feet above sea-level.

The first signs of the nitrate fields—the only signs of any habitation at all—are the electric railway that runs to Tocopilla, and the rows of pylons that convey electric power across the desert. The pylons follow the "road" closely, though the railway takes a different direction. I am told that the scenery resembles the "Mud Lands" of Arizona—a sandy, rocky surface stretching as far as the eye can see, the monotony only modified by low ranges of hills. In the brilliant sunshine the model village built for the American staff made a pleasant change of scene as we reached Maria Elena. There are four hundred "foreign" engineers and managers who direct the Chilean workmen, and the camp is furnished with a hospital and a club to provide for the social life of the community. Hard tennis courts were baking in the mid-day heat, but powerful electric lamps arranged round the netting indicated that games are played at night, when the temperature is comparatively cool. Little pots of nasturtiums and other climbing plants are grown in the shade on the verandahs of the houses.

A VIEW OF THE WORKS.
Near the village of Maria Elena stand the enormous works and chimneys where the chemical treatment of nitrate ore is carried out on a large scale.

Not far from the village stand the enormous works and chimneys where the chemical treatment of the nitrate ore is carried out. The scene here resembles any big chemical plant in the north of England, except that the desert sky is brilliantly blue in contrast with the smoky atmosphere of our industrial towns. The nitrate fields at Maria Elena cover fifty square miles and are operated by the Anglo-Chilean Consolidated Nitrate Corporation. Although the English name is retained, this is now an American enterprise, having been bought by the Guggenheim interests five years ago. The American staff is supported by 4,500 Chilean workmen, and cordial relations have been maintained by reason of the careful labour conditions which the Chilean Government requires. One of the first steps when the industry began to pass into foreign control was the introduction of labour legislation, and in consequence the trouble that has arisen in other South American republics has been avoided in Chile. Work at Maria Elena is conducted in two eight-hour shifts, from 7 a.m. to 3 p.m. and from 3 p.m. to 11 p.m., and as much as 20,000 tons of ore are mined every day. The output of nitrate after the ore has been reduced averages 1,500 tons per day.

The initial operation is to remove the surface dust which covers the ore or *caliche*. Rails are laid across the fields to the areas under treatment and the mining plant is transported by

EXCAVATING THE NITRATE.

A mechanical shovel clears the surface of the ground to a depth of three to five feet, the dust being dumped by the giant bucket into railway trucks.

electric locomotives. About twelve areas are usually worked simultaneously, so that the field arrangements might be compared with an octopus—the permanent works being situated at the centre with temporary lines running out in various directions across the surrounding "fields." A particular line may, of course, remain unchanged for several months, but so stable are the weather conditions that the electric pylons are not driven into the ground adjoining the railway—their base is constructed like a toboggan, and when the line is moved each pylon is simply dragged to its new position.

After the line is laid a mechanical shovel is conveyed to the scene of action. Here it is set to clear away the surface to a depth of from three to five feet, the dust being dumped by the giant bucket into railway trucks. When the ground has been cleared a gang of men proceeds to drill the ground, making holes in the ore at intervals of six feet. The work resembles the familiar street operations in London, as compressed air drills are used; the chief distinction being the immense clouds of white dust which the drilling causes. The compressed air is conveyed from head-quarters through metal pipes, a pressure of eighty-five pounds being obtained at a distance of five miles from the generating plant. Power is provided by Diesel oil engines; eight units of five thousand horse-power are installed at Maria Elena, this plant being the largest of its kind in South America. All the water for the works is pumped up from the Loa River. After holes have been drilled over an area sufficient to yield about 4,000 tons of ore, charges of dynamite are inserted and blasting takes place. The next stage is conducted by another mechanical shovel, which loads the ore into trucks for transportation to the works. In a shift of eight hours about 9,500 tons of ore are mined.

Arrived at the chemical plant, the *caliche* goes through the familiar stages of treatment, commencing in the grinding machines. The ore is broken into small pieces the size of lumps of sugar, and travels along a mechanical feeder to the leaching baths. A wide belt several hundred yards in length continually feeds the tanks, each forty feet high with a capacity of 7,500 tons. A moving bridge ensures even distribution of the ore in each tank. When the mother liquor has been obtained by soaking the powdered ore, it is passed through pipes to adjoining buildings for purification. This process is carried out in several stages, and eventually the liquor is crystallized, having been sprayed through fine nozzles to assist cooling.

The synthetic processes for the fixation of atmospheric nitrogen or the extraction of nitrogen from the air are chiefly carried out by the German Haber-Bosch method. This was the method by which Germany, when cut off by the naval blockade from supplies of natural nitrate from the Chilean deposits, was able to obtain nitrate from the air to continue the manufacture of high explosives, while Great Britain and the Allies still had to depend on natural nitrate from Chile. Since the war an immense plant for the extraction of nitrogen from the air has been established in this country at Billingham-on-Tees by Imperial Chemical Industries, and similar plants are in operation in the United States, France, Italy, and many other countries. The principal processes are those invented by Professor Haber, a German, Georges Claude, a Frenchman, and Luigi Casale, an Italian. The world production of synthetic or atmospheric nitrogen—used mainly for fertilizer purposes as

DRILLING OPERATIONS.

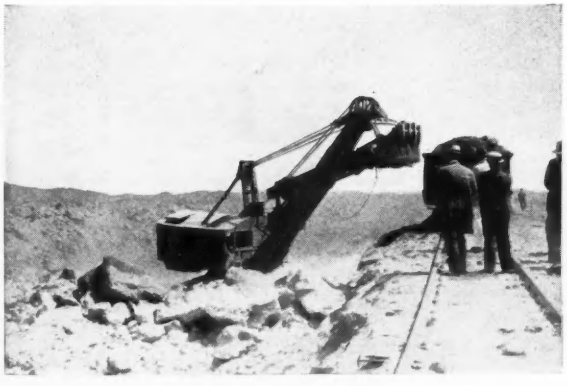
When the ground has been cleared, a party of men proceeds to drill, making holes in the ore at intervals of six feet. Compressed air drills are used.

sulphate of ammonia—now reaches an enormous total, and it is the post-war development of the synthetic industry that has caused the reorganization of the natural nitrate industry of Chile.

By the time the final process of crystallization had been inspected, I felt somewhat overcome by the heat of the many buildings through which we had passed. The fierce heat of the sun was cool beside the temperature in the power house, which approached 122° F. It was therefore a relief to see the brilliant white salt being packed in bags, ready for the market. In the yard by the crystallizing plant a large pile of salt formed a striking contrast with the dark skins of the Chilean workmen, who seemed quite surprised when I photographed the scene for *Discovery*.

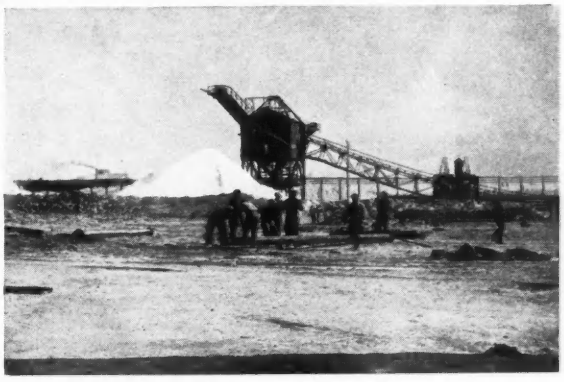
It is only in the past five years that mechanical mining has been introduced in the Chilean nitrate fields. All the digging and shovelling was previously done by hand and the resulting costs were comparatively high. This was of minor importance before the introduction of synthetic processes in Europe and the United States, which have had a drastic effect on the industry in Chile. Of more than a hundred fields actively worked at the end of the war, only ten are now in operation.

The situation became so drastic in 1927 that the Government instituted a Department of Mines to co-ordinate the smaller plants. This step was followed last year by a project to bring all the plants in the country under joint control, and a national company has been formed with the title "Compañia Salitrera de Chile." Production and sales will be centrally organized, and it is expected that the nitrate fields will take a new lease of life as a result of this enterprise. The position has been further improved through



LOADING THE TRUCKS.

The next stage in the work is conducted by another mechanical shovel which loads the ore into trucks. Within eight hours about 9,500 tons are mined.



THE CRYSTALLIZING PLANT.

In the yard by the crystallizing plant, a large pile of salt formed a striking contrast with the dark skins of the Chilean natives in the foreground.

the agreement recently concluded with the synthetic producers abroad to ensure that markets are shared.

The Compañia Salitrera, shortly known as "Cosach," has been organized under a special act of the Chilean Congress. Thirty-six nitrate producing companies and firms representing over 95 per cent of the nitrate productive capacity of Chile have, through their boards or managing interests, indicated their intention of joining the company. The Chilean Government has exempted from the export duty on nitrate (amounting to about £2 10s. 6d. per metric ton) all nitrate exported by the company and its subsidiaries and has made available to the company, without cost, Government-owned nitrate deposits estimated at 150,000,000 metric tons of recoverable nitrate. The Government will occupy a position of partnership in the company through the ownership of 50 per cent of the total authorized capital stock. Nitrate exports from Chile have averaged 2,269,080 metric tons for the last twenty nitrate years and 2,365,352 metric tons for the last five nitrate years. Of this average tonnage, the nitrate companies and firms which have indicated their intention of joining the company have exported about 93.5 per cent.

Meanwhile, the Anglo-Chilean company is applying the Guggenheim process to replace the Shanks process hitherto employed, and it is expected that this will further assist the prosperity of the industry. I saw several of the new processes at work and obtained a most favourable impression of the efficiency that characterizes the Chilian nitrate fields at the present time. How long the natural product will be able to compete with the European plants remains to be seen, but there is no doubt that every effort will be made by the Chilean producers to maintain their position in the world's markets.

The Remains of an Ancient Isthmus.

The discovery of fossil foliage in a Pacific island which has been treeless for centuries is announced by the Carnegie Institution of Washington. Evidence is thus provided of the fact that Asia was once connected with North America by means of an isthmus, of which St. Lawrence Island represents the remains.

A LITTLE south of Bering Strait in the North Pacific lies the island of St. Lawrence. It is forty miles from the shores of Asia and slightly over a hundred miles from the nearest point of Alaska, to which it belongs. Situated on the fringe of the Arctic zone, the island is sparsely populated by Eskimos who engage in whale fishing and in trapping the wild foxes which abound there. There was once a large population, but famine and pestilence have reduced the inhabitants to a bare four hundred.

During the summer months St. Lawrence is carpeted with a tundra vegetation consisting of grasses, moss, lichens and berry bushes. No tree or shrub is to be seen, a condition which has apparently obtained for centuries. But the recent discovery of fossil foliage cones and wood reveals the fact that about fifty million years ago this barren island was covered by a forest of sequoias, apparently exactly similar to the living redwoods of California. For many years periodical reports have reached the Carnegie Institution of Washington stating that fossil sequoias have been seen in St. Lawrence Island, but because of the inaccessibility of the island it was long impossible to obtain specimens. Recently, however, small blocks of reddish slate were discovered in a high bank which bordered a lake. These proved to be rich in fossil plants, and specimens were sent to the Carnegie Institution.

Most of the rock is a heavy grey shale, covered thickly with impressions of leafy twigs of sequoia and of a few fragmentary leaves which are probably species of poplar, alder, and sycamore. Cones and wood of sequoia are included in the collection, and one of the pieces of fossil wood appears to have been a redwood burl, an irregular growth frequently developed on the redwood trees of to-day. There is even the impression of a leaf fragment which may represent one of the rhododendrons, now so abundant in Asia and quite common in parts of North America.

ST. LAWRENCE ISLAND.

The presence of fossil sequoias in St. Lawrence Island is evidence that the island was once an isthmus connecting the continents of Asia and North America.

More than fifty years ago an eminent botanist declared that there was an astonishing similarity between the flora of North America, particularly the flora of the Atlantic United States, and that of Japan, Manchuria and Northern China; that the similarity of American and Asiatic flora was much more marked than the similarity of the floras of America and Europe; and that these considerations suggested an ancient continuity of territory between America and Asia which enabled both plants and animals to pass freely from one continent to the other.

Even in 1850 study of the fossil records of ancient life had advanced far enough to enable botanists to cite the wide distribution of the sequoias in the Arctic region during the Tertiary period as evidence supporting the theory of the existence of such a land connexion. In later years students of plant and animal life, both living and fossil, have accumulated a wealth of evidence to show that, from the days of the dinosaurs down to the present, there have been similar or identical animals and plants on both continents. This strongly suggests a former migration route between the two continents—a "land bridge," so to speak,

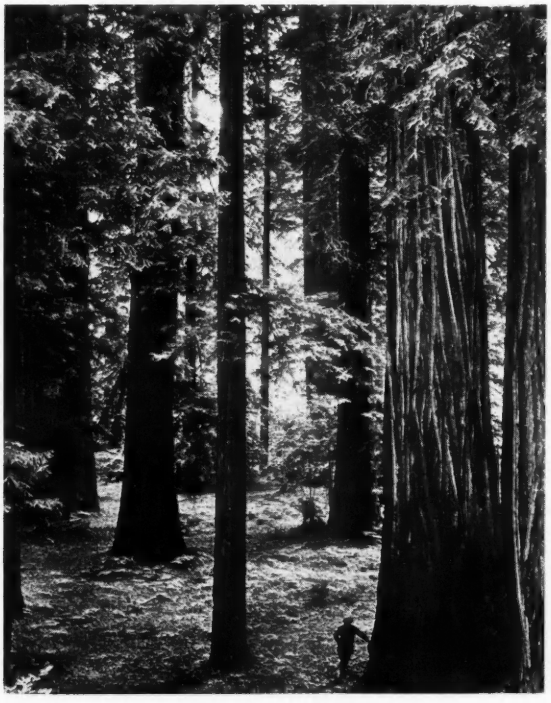
across which interchange between Asia and North America took place.

Thus the great titanotheres, gigantic beasts allied to the rhinoceros which lived in western America fifty million years ago, have been found buried in the rocks of the Gobi Desert. Dinosaur eggs, first found in Mongolia, were discovered, although in fragments only, during the past summer near Red Lodge, Montana. Striking examples of similarity between the two continents in types of living animals are also to be noted. Thus the true alligators, as distinguished from crocodiles, are found only in the south-eastern United States and the Yangtze River. Again, the American mountain sheep is more nearly related to the Kamchatkan sheep than to any of its neighbours, while the nearest relatives of the Rocky Mountain goat are the goat-antelopes of eastern Asia.

Among living plants about two hundred are identical in the two regions and several more are very near relatives. As to fossil plants, the ancient ancestors of the ginkgo tree, a native of Asia at present but once an inhabitant of northern Europe and the whole Arctic region to Alaska,are represented in fossil deposits at Washington and Oregon. Again, on the spacious grounds of the Temple of Heaven in Peking, and elsewhere in northern China, grows an elm tree with small, thick leaves quite unlike those of any other living elm. Recent investigations in the Tertiary rocks of Oregon disclosed the fact that the ancestor of this peculiar elm formerly lived on the American continent. In the same Tertiary deposits the fossil remains of hawthorn, chestnut and sumac were found, whose modern descendants are to be seen on the hills of central and northern China.

THE LATEST DISCOVERY.

Impressions of the sequoia leaves are seen in this piece of rock from St. Lawrence. It is clear that the island once lay in the path of a continuous forest.



GIANT REDWOODS IN CALIFORNIA.

There are only two living species of the redwood tree—the giant sequoias and the coast redwoods. They are now restricted to the forests of California.

To mention only one other example from the plant world, the redwood, now confined to California, has been found in fossil form over a wide area in the northern hemisphere. In the light of accumulated facts, it now seems certain that in the Tertiary period great forests of these magnificent trees flourished over the region in western America which extended from Texas and Colorado into Yellowstone Park and northward into Canada and Alaska. Fossil remains have also been found in Greenland, Siberia, and localities in Europe from France and Hungary to Spitzbergen.

A recent search was made for evidence of the extension of the Tertiary redwood forest in Asia. In a coal mine at Fu-shun, Manchuria, not only were remains of ancient redwoods found but fossil alders, oaks and maples—all present-day companions of the redwoods of California—were also discovered. Still farther to the west, in Chihli Province, evidence was forthcoming which showed that a redwood forest covered the region during the Cretaceous period, which antedates the Tertiary by many millions of years. It is now clear from the nature of the new discoveries that the treeless St. Lawrence Island, midway between the two continents, lay in the pathway of a redwood forest belt which was apparently

continuous from North America to Asia. Thus the latest evidence from the fields of botany, zoology, geology and palaeontology renders highly probable the conjecture of eighty years ago that the two continents were once united.

There is little likelihood that an ocean current could have carried cones or seed from either mainland to the island, for cones of the living redwood which contain seeds capable of germinating do not usually float when they fall into the water. Indeed, one of the common tests for the viability of redwood seeds is to place them in water, whereupon the living seeds sink. There is, of course, the possibility that seeds may have been carried by birds or by the wind, or that currents may have carried cone-bearing branches, but against these possibilities is the fact that, among the islands off the part of the Californian coast where the redwood now flourishes, living redwood trees are not known. Although this is partly due to the fact that the island environment is not as suitable as the valleys of the mainland—protected as they are from the wind and having a proper combination of soil and moisture—it is also partly due to the difficulty of seed distribution. Such means of migration appear to be unlikely, and it is believed that St. Lawrence Island represents the remains of a "land bridge" which connected Asia with North America—a bridge over which the redwood forest was essentially continuous during the first half of the Tertiary period at least, and across which not only plants and animals but possibly our human ancestors were able to pass from continent to continent.

Foreign Travel in 1931.

FACILITIES for foreign travel to-day are so extensive that there are few parts of the world which the tourist is not given ample opportunity of visiting in speed and comfort. Indeed, holidays abroad are, perhaps, coming to be regarded as commonplace by the seasoned tourist, but to the less favoured majority the opportunity to visit other countries does not occur very frequently—only, perhaps, once a year when the annual holiday is taken. As in previous years, therefore, we include in this number a brief review of the latest facilities offered by the British travel companies, which may be appropriate at a time when plans for the summer holidays are being made.

A popular Mediterranean tour is arranged by the Bibby Line for passengers who are seeking a short cruise. From the beginning of April until early October there is a combined cruise and tour through the Riviera to Marseilles and thence to Genoa, returning via Algiers to Southampton. An alternative return route by motor coach is available by way of the Route des Alpes to London. The introduction this month of the new twin-screw motor ship *Venus* enables passengers to travel for the first time from England to Norway in less than a day. The B. and N. Line Royal Mail vessels have for many years maintained the most frequent passenger service between Newcastle and Bergen, and the new ship will sail twice each week, reducing the time to twenty-one hours.

There is a corner of France which is comparatively unexplored by British tourists: it is well worth visiting. It commences on the border of the extreme Eastern Pyrenees at Port-Vendres, or Port of Venus. Perhaps, to find it at its best, one should visit it in the months of May or October, but it is also delightful in the early spring. Tours in the Eastern Pyrenees are arranged by the Paris-Orleans and Midi Railways of France, and one of the most popular is the combined rail and motor tour from Paris via the Route des Pyrenees.

Enjoying sunshine almost throughout the year, the heat tempered by the trade winds, the West Indies have aptly been named the "islands of sunshine." For those who are able to take an extended tour, the steamers of the Harrison Line sail at regular intervals from London. Calls are made at Barbados, Grenada, Trinidad and British Guiana, and passengers may break the journey as they choose. All the places visited are British Colonies where English is spoken and English money is current.

In these days of luxurious travel a cruise of twelve thousand miles in an ocean liner cannot be claimed as an innovation. But in the six weeks' cruise to Portugal, Madeira and the River Amazon, the Booth Line provides a tour which is distinctly off the beaten track. The equatorial forest through which the Amazon has its course possesses practically no railway lines and much of it is still, of course, unexplored. Several unique shore excursions are available. At Pará, which is the gateway to the Amazon, the natural forest park should be visited. This area of tropical vegetation, which was left untouched when the land was cleared to make room for the expansion of the city, serves as an effective introduction to the Amazon jungle.

New Developments in Wireless Communication.

By Lieut.-Col. Chetwode Crawley, M.I.E.E.
Inspector of Wireless Telegraphy, G.P.O.

*A new field of wireless communication was opened up last month when conversations were conducted across the **English** Channel using aerials of an inch in length. This is among the developments here described.*

THERE has been no slackening recently in the development of wireless communication. Progress, in fact, has never been so rapid as during the last few months, in spite of the gloomy financial conditions throughout the world. The present advance dates from Marconi's surprising announcement that in short wave working lay the future hopes of long range communication. The truth of Marconi's prophecy, founded on his own experiments in co-operation with Mr. Franklin and Mr. Mathieu of the Marconi Company, was proved correct when the beam wireless telegraph stations erected by the Company for imperial communications were put into commercial operation by the Post Office.

The whole of the wireless world had been waiting anxiously for the result; and it was well worth waiting for, since the success of the short wave beam circuits changed the whole course of development in wireless telegraphy throughout the world. At first there was even a fear that the new channel might mean the destruction of the old—the submarine telegraph cable. But that was not to be; the new channel was to be a combination of the two, the submarine cable and the short wave wireless telegraph. As this country was the first to try out short wave wireless telegraphy, so was it the first to recognize that practical development would require the merging of cable and wireless interests for telegraphic communications over great distances. Our long range cable and wireless interests have already come together in a big commercial merger, and similar mergers have taken place in other countries but have not yet had full rein in the United States, on account of legal difficulties. Strenuous efforts are now being made, however, to overcome them.

Transatlantic Telephony.

Developments in transatlantic telephony have already been described in *Discovery*. The existing system has proved so successful in practice that not only are additions to the wireless channels contemplated, but it is also intended to lay a transatlantic submarine telephone cable between this country and the United States. No such telephone cable has yet been laid, but the results obtained with the latest telegraph cables of similar type have convinced the experts that there is now no technical reason for doubting the successful working of the new project. It is intended that the submarine circuit should supplement and not supplant the wireless circuits. This is the very latest development in electrical communication, and if it should prove financially successful it will open up great possibilities for the development of world-wide communication.

Use of Short Waves.

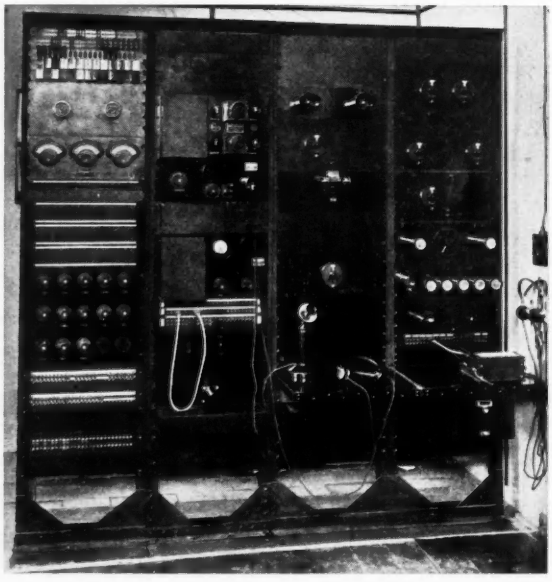
Meanwhile great strides have been made in long range wireless telephony on short waves during the past year. In many cases it may take a long time to establish connexion, and conversations will often be an expensive luxury, but the fact remains that the progress made during recent months is little short of marvellous. It is, however, only a commencement; much remains to be done before world-wide telephony is placed on a satisfactory commercial basis comparable with telegraphy. But it must be remembered that the latter, or rather the submarine cable part of it, has had a sixty years' start.

So far the public has made little use of the wireless telephone services available between subscribers on shore and Atlantic liners. No increase has, therefore, been made in the number of liners so fitted. In small craft, such as trawlers, there is a growing tendency to fit telephony for inter-communication, but as far as communication with the shore is concerned telephony for these small craft has not yet reached the stage when it can be considered as a sound financial proposition. The Post Office station near the Humber, which was fitted some years ago, is the only station available here for this type of communication, but Wick Radio on the north coast of Scotland has just been fitted by the Post Office with the necessary apparatus. Some other European countries are making similar efforts in this direction, but the whole idea, from a commercial standpoint, is still in its infancy.

In telegraphy, progress is taking place for the most part along the lines predicted by Marconi, that is to say, the extension of short wave circuits throughout the world. New wireless telegraph circuits have recently been opened between England, Japan and Persia; France, Turkey and Algiers; Spain, Mexico and the Philippines; and the U.S.A., Shanghai and Manila. South America, too, has opened services between Chili, Panama and New York; and a number of new services have been opened between various places in Africa.

Although many new services have thus been brought into operation during the last year, financial receipts have been sadly affected by the general depression in trade. On the other hand, the technicians have not been slow to take advantage of the experience gained in working this great world network of short wave stations. Further experimental work has been done to devise means of overcoming "fading" effects. The problem has been attacked both at the receiving end and at the sending end. At the former the most successful results have so far been obtained by the use of separate or spaced aerials. At the latter, modulation of the transmitter's output has proved effective in certain cases, and much has been done, too, by the use of beam aerials of various descriptions. The fact remains, however, that fading is still the greatest difficulty to be overcome in short wave circuits, with the exception of the fundamental problem of mutual interference between circuits on the same or slightly different wave-lengths. Recently, a special circuit called the Stenode Radiostat has been devised, and it is claimed that it should be of great assistance in this direction.

Considerable strides have also been made within the last few months in minimizing the effect of the transmitter on the receiver which is used in conjunction with it at the same end of the circuit. At present, the practice is to concentrate the transmitters at one place, such as Rugby, and the receivers at another place some distance away, such as Baldock, so as to reduce the interference caused by the former on the latter. But recent experiments show that it is often possible to reduce the distance until the two stations can actually be concentrated on the same site. The first step towards this ideal was taken when it became necessary to send and receive messages at the same time in ships—simultaneous telegraphy and telephony, for instance, in liners. There are still, however, many difficulties, especially in the case of powerful transmitters. The advantage of having the two stations on one site is that it greatly economizes running costs, which are always heavy in wireless working compared with line systems.



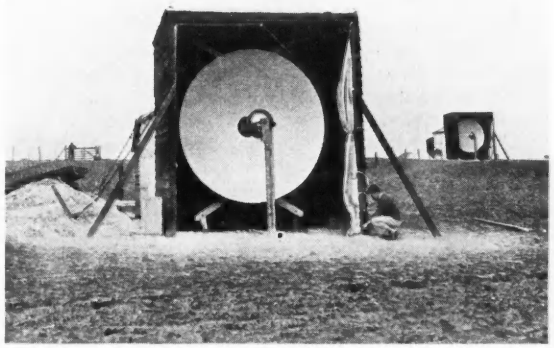
TELEPHONE COMMUNICATION WITH SHIPS.
A wireless telephone receiver at Baldock for communication with Atlantic liners. So far the public has made little use of services of this type.

In addition to these improvements in wireless telegraphy as it is generally understood, a great deal of success has been obtained in the development of facsimile transmission, or to give it its official name, "picture telegraphy." This form of telegraphy has great possibilities. It is true that the Marconi Company has operated such a wireless service across the Atlantic for some years, that the Post Office opened up line services to various continental countries during last year, and that the results from a commercial point of view have been far from exhilarating; but, even so, no one can doubt that, when further developed, this form of communication will become of first-rate importance.

The future of facsimile transmission depends to a great extent on attaining high speeds of working. This is not so important in the transmission of pictures or drawings, where it has no competitor, but it is of vital importance in the transmission of printed matter, typescript and writing, where it has to compete with telegraphy. It is in this sphere that facsimile transmission may look for its greatest future from the financial point of view. In the recent report of the

Council of the Empire Press Union it was stated that "the time is now in sight when it will be possible to telegraph a complete newspaper facsimile—a development of momentous importance of which the ultimate results are difficult to foresee." The problem of working up the speed presents many difficulties, but these are now being attacked with such energy that complete success is only a matter of time.

In the services with ships and aircraft, the most interesting developments, apart from telephony, are those in connexion with navigation, that is to say, directional apparatus. Already more than one-fifth of the ships carrying wireless are fitted with directional receivers by which the bearing of any ship or station which is sending out wireless signals can be obtained within an accuracy of two or three degrees. The latest form of apparatus has just been put on the market but is not yet in commercial use. Provided that there is no strong wireless interference, the bearing is automatically indicated by means of a pointer on a scale as soon as the apparatus is tuned up to the signals from the ship or station whose bearing is desired.



THE NEW WIRELESS APPARATUS.

The transmitter and receiver (right) used in the demonstration at Dover. Cross-channel conversations were conducted using aerials less than an inch long.

Wireless beacons to assist aircraft in approaching an aerodrome are receiving much attention, and an interesting form of directional beacon has recently been developed in America. Two directive aerials are used, each sending out a beam of waves. Night errors are very prevalent in wireless directional work, and a new form of aerial which overcomes these errors has recently been devised in this country.

A great deal of experimental work has been carried out during the last few months on the problem of the utilization of very short waves. This problem has been forced on the notice of wireless engineers by the fact that it has become obvious that, owing to the mutual interference between wave-lengths of the order now in use, the available channels of communication will very soon become less than the demand; in other words, the ether, with the waves now in use, is congested. The difficulty with the extremely short waves is that they cannot pass over obstacles as the longer waves can; in fact, the shorter they become the more do their properties, very naturally, approximate to those of visible light rays. On the other hand, the fading effects which are so noticeable on the short waves now used appear to be absent on the very short waves, and the amount of power required for communication is extremely small.

An interesting demonstration of the possibilities of extremely short waves was given last month by the International Telephone and Telegraph Company when good wireless telephone communication on an eighteen centimetre wave was conducted between the heights of St. Margaret's Bay at Dover and Blanc Nez near Calais. The transmitter consisted of a "micro-radion tube"—a special form of valve—with an aerial of about an inch in length, the waves being transmitted as a beam by means of a system of two metal reflectors; the larger was about ten feet in diameter. Similar arrangements were used at the receiving end of the circuit. The transmitter and receiver at each terminal were separated by about eighty yards to facilitate two-way conversation. The radiated power was only half a watt, and the quality of speech obtained across the Channel was excellent.

An ingenious "talking beacon," the first of its kind in the world, has recently been erected at the Cumbrae lighthouse in the Clyde estuary, and is operated during foggy weather. Here the ordinary blasts of a fog signal are used in conjunction with a wireless telephone transmitter worked off a gramophone record which counts out miles and cables in speech. By this means it is possible for a ship to ascertain its distance from the lighthouse.

In broadcasting, the line of advance has been in the multiplication of high power stations. In Europe progress proceeds gaily, if less magnificently, than in the United States, and Moscow leads the way at the moment by planning a five-hundred kilowatt station. Meanwhile the B.B.C. continues to pursue its more modest, and more sensible, scheme by bringing into service the new regional station at Huddersfield.

Book Reviews.

The Stars in Their Courses. By Sir James Jeans. (Cambridge University Press. 5s.).

This book is an expansion of a course of wireless talks on astronomy delivered during 1930. It is written in an attractive popular style and assumes no previous knowledge of the subject. It begins by pointing out that the inhabitants of earth are favoured beyond those (if any) of Venus, which seems to be continually veiled in cloud; this would prevent observation of heavenly bodies. The author explains that even under these conditions a knowledge of the rotation of our world might be gained by such means as the Foucault pendulum or the gyro-compass.

After a brief preliminary sketch of the whole field, we embark in Chapter II on a trip to the sun in a magic rocket. The changing aspect of earth, sky and sun during the voyage are vividly portrayed. We are told to brace ourselves for the shock of striking the sun, and then find that there is no shock, as we meet nothing solid but only gas of gradually increasing density. We go right down to the sun's centre, where we experience a temperature of forty million degrees and a pressure of forty thousand million atmospheres; but even here the matter is not solid, the heat causing rapid motion of the atoms. On emerging from the sun we are taken back millions of years in time, and watch the approach of the other star which, according to Jeans and other cosmogonists, produced mighty tidal waves on the sun, resulting in the expulsion of a long filament of gas which condensed into a row of planets. We visit the planets one by one, with the aid of photographs of the moon, Venus, Mars, Jupiter, Saturn and Pluto; the last is a tiny dot but the others show a good deal of detail.

We then take the lengthy flight to the stellar regions, and study the Milky Way; we find that the sun is not at its hub, as Herschel thought, but a third of the way from hub to rim. The different types of stars are described, and the course of a star's evolution from one type to another. We learn that there are countless other Milky Ways besides our own, at distances so vast that their light takes millions of years to reach us. The idea of the nebulae being "island universes" was put forward by Sir W. Herschel a century and a half ago; it was discredited for a long time, and it is only in the last few years that it has been put on a firm basis. The book ends with a useful "Guide to the Sky," telling us when different planets or constellations are visible, and where to look for them.

A few slips should be noted, as they might mislead the beginner. It is stated on page 4 that a weight suspended by a string would continue to swing in the same direction in space; this is not true unless we are at the north or the south pole; elsewhere the fact that the swing has to be in a vertical plane prevents the direction in space from remaining the same. On page 17 the steady shift of the earth's equator is ascribed to the sun alone, but actually the moon's share of it is more than double the sun's share. It is stated on page 24 that a speed of seven miles a second will suffice to carry us away from the earth, and that the sun's attraction will then pull us to it; actually we must start with a speed of over twenty miles a second; we cannot fall into the sun unless we move quickly enough to cancel the earth's speed of eighteen and a half miles a second. There is a slip on page 64 similar to the last; it is implied that if two of the tiny bodies forming Saturn's ring collided, their fragments would fall on the planet; this could only happen if the bodies were going round Saturn in opposite directions, which is not the case.

These little slips remind us that "Even Homer nods at times"; perhaps it is a comfort to beginners to find that the greatest astronomers can trip now and then.

New Discoveries Relating to the Antiquity of Man. By Sir Arthur Keith. (Williams & Norgate. £1 1s.).

Evidence is not lacking that the public is keenly interested to-day in the announcement of any discovery relating to early man. Many readers will be grateful to Sir Arthur Keith for this volume in which he reviews the evidence of the numerous finds bearing upon the antiquity of man brought to light since 1924. One point immediately strikes the reader on glancing through these pages. In a period little longer than that covered by the author; in fact, since the announcement of the discovery of the Rhodesian skull in 1921, the problem of man's antiquity has become world-wide. Until that date, our evidence relating to early types of man, except the all-important *Pithecanthropus* from Java, was drawn almost entirely from Europe. The time was not yet ripe for the just appreciation of the Oldoway skeleton discovered in East Africa in 1914, even had the war not intervened; in the archaeological field a point had not yet been reached at which a synthetic view of the extra-European evidence was possible—indeed it is only now that we are approaching that stage with the gradual correlation of the evidence from South, East and North Africa, India, Palestine and China.

The mere list of the discoveries with which Sir Arthur has had to deal would in itself illustrate the difference in the position as it stands to-day. It is drawn from all five quarters of the globe, ranging from South Africa to Greenland. Even America has to be brought under consideration, although, in spite of probabilities, certain evidence of early man is there still to seek. It is, perhaps, not without significance that the latest and most important find comes from China where, ten years ago, despite the hopes of far-sighted anthropologists, there seemed little prospect of discovery.

So much of this work is of the most intense interest, and all is so important, that it is difficult to select points for special mention. It opens with an examination of the Taungs skull, *Australopithecus*, a rival claimant to Rhodesian Man as South Africa's prime contribution to the problem of the origin and descent of man. The author is unable to admit it to a place as a precursor of man, as is claimed for it by Professor Raymond Dart who first announced it to the world. He regards it as entirely anthropoid. The reader will naturally look to Sir Arthur for an authoritative pronouncement on Peking Man, and will not be disappointed; for although data relating to the skull discovered in December, 1929, were not available at the time of writing, the author sets forth a detailed analysis of the characters of the teeth, jaws and other fragments which gives the reasons for regarding *Sinanthropus* as of overwhelming importance in the human pedigree. Sir Arthur's views on the Galilee skull and the new Gibraltar skull have already been made widely known; his suggested revision of the dating and classification of the skull found in excavating for Lloyd's new building in the City of London will arouse keen controversy; but it would be a pity if these outstanding features in his book were allowed to overshadow the interest and value of his work on the predecessors of the Bushmen and the modern Australian and the characters of the early races of Egypt and Mesopotamia.

It is hardly necessary to say that this book, like so much of the author's work, appeals as strongly to the layman as the expert. Detailed as it is in its discussion of evidence, the careful exposition and explanatory diagrams make it possible for any to follow the argument readily. For the anthropologist and the archaeologist the chapters on *Australopithecus*, Peking Man and the London Skull would alone make its publication an event of importance in the annals of scientific literature.

Climate. By W. G. KENDREW, M.A. (Oxford University Press. 15s.).

Mr. Kendrew has supplemented his well-known book, "The Climates of the Continents," with an equally graphic general introduction to the subject. The work is a remarkably good example of the text-book type; the various climatic phenomena are most ably described and illustrated, and are clearly explained in the language of elementary physics. The arrangement of the matter is equally typical; after a brief opening chapter on climatological observations in general we have the mainspring of all climate, namely insolation and temperature. Differences of temperature lead to differences of pressure, and their resulting winds to humidity, cloud, rainfall, and fog. In the later part of the book the same physical principles are applied to local details of climate—mountains and plateaux, the weather of temperate regions, local winds, and various climatic provinces such as the Mediterranean.

The descriptions of the winds and weather are reinforced by a series of well chosen quotations from "the man on the spot," while some of those which are not marked as quotations are so excellent that we suspect the author of writing from personal experience. There are some fine photographs, noteworthy among which is a tornado in Minnesota, and another feature to be commended is the inclusion of a number of autographic records, barograms, thermograms, etc. The chapters on weather in temperate regions are enriched by a useful set of typical synoptic charts; in fact, the book is illustrated throughout with great profuseness.

The lucidity and simplicity of the explanations will commend the book to students and teachers without expert knowledge of the subject, but the simplicity is at times misleading. In the past fifteen years meteorology has travelled far beyond the stage of elementary physics, and much of the matter will strike a professional meteorologist as old-fashioned. The most noteworthy example of this is figure 31, which shows the "planetary" winds, namely, two belts of trade winds blowing in towards the equator, and two belts of "westerlies" inclined towards the poles, all four belts completely surrounding the earth. This was a favourite illustration in the text-books of physical geography at the beginning of the century, but not only does it correspond with nothing in nature: it is even physically impossible. The same criticism applies to figure 32, representing the supposed upper winds; there is no evidence whatever in support of the distribution shown, and it could only exist if pressure at a certain height could continually decrease from east to west round the same parallel of latitude.

The author explains that "the general circulation of the atmosphere is by no means fully understood, and other representations of some of its features than the scheme of figure 32 have been given by meteorologists." They have! The picture of the circulation of the globe given, for example, by Bjerknes, might well have replaced these two museum specimens. Similarly, the theory of the winds in a field of pressure in a rotating globe is so incomplete as to be misleading, and the explanation of the convectional rains in the rear of a depression is only partly true.

Side by side with these blemishes, however, are some very modern ideas. The description of the origin of cyclones is a brilliant exposition of some ultra-modern theories of dynamical meteorology, and could hardly be bettered. The theory of the origin of depressions in temperate latitudes at the "polar front" is fairly described, and the objections to it clearly stated; the author shows his independence of thought by with-holding judgment as to its correctness. Here the reader would have been assisted if one or two of the charts of depressions had been re-drawn to show the warm and cold fronts. On the whole, the treatment of the weather aspect of climate is so good as to compensate for the occasional use of obsolete ideas, and makes the book worthy of attention.

Amulets and Superstitions. By SIR E. WALLIS BUDGE. (Oxford University Press. 30s.).

When Sir Wallis Budge was Keeper of Egyptian and Assyrian Antiquities in the British Museum, he tells us, he kept a note of the questions he was asked to answer by members of the general public and others. When he retired, he took his notes with him, and this book is the answer to those questions. Need any more be said of the breadth of its appeal, especially when he tells us that instead of "Superstitions" he should have used the word "Magic." There are few people, however free from superstition they may pride themselves on being, who are not interested in at least some aspect of luck and magic from one point of view or another—it may be only to despise it as a degrading superstition. If so, this book will tell them exactly what it is they despise as frivolous and superstitious; while those who are frankly curious about the quaint vagaries of the human spirit in its desire to master the future, or to be made aware of what it holds in store for them, will find enough here to hold their interest for some time to come.

We are not here concerned with amulets in general. As the author says, that subject exhaustively treated would require many volumes and a syndicate of writers. Sir Wallis has confined himself to amulets in ancient Egypt and Mesopotamia with the beliefs of the later Kabbalists, Gnostics, pagan and Christian, and the astrologers. Anyone who has done no more than dip into the subject will appreciate how much labour is required to cover the field adequately even when thus limited. In addition to spells and incantations, amulets and lucky symbols, methods of divination and the like of the ancient world, the author has added material that he has gathered among fortune-tellers, astrologers, crystal-gazers, and other types of magician whom he has met while on official missions in Egypt and the East.

The amulet, more familiar to modern civilization as the mascot, may seem a foolish superstition or merely a fashionable whim, but it must be remembered that it holds an important place in the history of religion. According to an ancient Egyptian story dating from one of the earlier dynasties, magic, the vital principle of the amulet, was invented by the gods for the benefit of mankind. The author, giving perhaps too much weight to his experience of the Mediterranean area, is inclined too much to attribute the use of the mascot to the influence of the evil eye. Whether he is correct in this or not, there can be no question that the study of the amulet has drawn him into many fascinating bypaths in the history of belief—the

terra-cotta devil traps of Babylon, the lore of the ring used as an amulet, the virtues and qualities of precious and semi-precious stones, and the significance of colour, shape and material in the amulet. If you wish, for instance, to be protected from poison, the bite of reptiles and diseases of the eye, you must wear a turquoise; it will warn you of approaching death, when it changes colour.

For an instance of the persistence of these primitive forms of belief the reader may turn to the chapter which deals with the familiar use of the wax image as an instrument for inflicting harm on an enemy. It was in use in Egypt in the time of Rameses, and was one of the commonest grounds of indictment against European witches in the fifteenth, sixteenth and seventeenth centuries; it occurs in modern witchcraft, even in England to-day.

The swastika, the cross, the theory of numbers, the evil eye, the various forms of divination, and many other details of magic which illustrate or elucidate the nature of the amulet and related beliefs are here figured and described with a breadth of scholarship and a lightness of touch which make the book a delight to read as well as a storehouse of information.

The Japanese Earthquake of 1923. By CHARLES DAVISON. (Thos. Murby. 7*s.* 6*d.*).

The earthquake in South-east Japan, which at noon on 1st September, 1923, devastated Tokyo, Yokohama and the naval port of Yokosuka, is famous as having caused the greatest financial damage (estimated at £550,638,300), the highest established death roll, and the greatest vertical earth-movement due to any known earthquake. The death roll is uncertain, but it is clear that the loss of life was due mainly to such accidents as the drowning of people who were bathing on the shore, and passengers in a moving train being killed when it was thrown off the line. The high mortality in Tokyo was due to secondary consequences of the earthquake. At Yokosuka, the naval station close to the centre of the origin, the violence of the earthquake was equal to that in Assam in 1897. At Yokohama the direct shock was also disastrous; it tore fissures in the ground and along the streets, hurled motor-cars into the air, threw the hospital over the Bluff and shattered the strongest buildings. But at Tokyo the shock was relatively mild. In parts of the city it did only minor damage; it is true that it shook down or injured 54 per cent of the brick houses; but they were frail; it damaged only 10 per cent of those built of reinforced concrete, and six of the sixteen sky-scrapers were quite uninjured. Tokyo was built, as Dr. Davison expresses it, as a huge village with lightly built inflammable houses, crowded in streets too narrow to admit a fire engine. When the shock came the charcoal cooking pots were overthrown, fires started simultaneously in many places—in Yokohama there were 208 independent outbreaks—and as the water mains were flimsy they were broken and in many places no water was available to resist the flames. The people crowded into the open spaces and on to the bridges and were suffocated by the thousand. The climax occurred at the yard of the Military Clothing Depot, where forty thousand people are said to have congregated as the fires were travelling away from the locality and it appeared safe. At six o'clock the wind suddenly changed in direction and blew with hurricane force it rolled clouds of smoke across the open yard. The adjacent buildings caught fire and "so far as we know, not one soul escaped." The cause of the earthquake was due to a violent disturbance in the earth's crust across and beside Sagami Bay. This movement must have been the result of a long accumulating stress, and its relief by the earthquake has been followed by comparative quiescence, so that it may be hoped that this part of Japan will have a long period of seismic repose.

Owing to the unique interest of the earthquake both from its social and scientific aspects, this concise and critical summary of the evidence will be of great value. It states all the main facts and conclusions and gives full reference to the extensive Japanese literature on the subject. The book is illustrated by six plates. Incidentally, the statement on the title page that it contains forty plates and diagrams is ambiguous: the illustrations are six plates and thirty-two text figures. The author pays a high tribute to the cool and dauntless courage with which the people of Tokyo behaved during the catastrophe.

Who Were the Greeks? By J. L. MYRES. (Cambridge University Press. 30*s.*).

This treatise on the early history of the Greek people, based on lectures delivered in the University of California, is profoundly interesting and stimulating. For the author takes the widest view of his subject, which, in his own words, is "to examine the Greeks' own beliefs about their origin in the light of modern advances in the study of race, language, religious beliefs, arts and crafts, observances and institutions, to supplement and revise their actions from sources of information and methods of enquiry not available in antiquity, to take note of our own ignorance in many of these matters, and to submit a programme of research."

This involves a reconsideration of what is known about folk-movements in the Eastern Mediterranean during the Bronze Age, a full discussion of such archaeological problems as the origin of the typical Greek *fibula*, or safety-pin, an analysis of the evidence afforded by philology and comparative religion, and an inquiry into the literary sources which include the famous Catalogues of Trojan and Achaean allies in the "Iliad" and the genealogies of ruling families that were preserved in the Hellenic folk-memory. The book covers a wide field, and a mass of facts is brought together, but the author never loses his grasp of his argument. Each detail, familiar or unfamiliar, is made to play its part in buttressing his provisional conclusions, and incidentally to make more definite and coherent our mental picture of the Aegean in the second millenium before Christ, when the historic Greece was taking shape.

No summary could do justice to this masterly book. It must be read—and read with close attention. But it may be useful to indicate the author's main conclusions. The Greeks looked upon themselves as a homogeneous race; but they were, in fact, of mixed descent, spoke different dialects of a hybrid tongue, had a composite religion, and differed in their manners and ideas. Yet the peculiar geographical characteristics of their Aegean cradle-land, during the relatively peaceful period from 1100 to 700 B.C., developed a special Greek type of man. In the little Hellenic communities, severed from one another by mountains or the sea, the Greek language in its varied forms became stabilized, and the Greek religion took shape out of a chaos of conflicting rites and beliefs, and a vigorous Greek culture was evolved, with Attica leading the way. Thus "the Greeks never wholly were 'one people,' but were ever in process of becoming."

Moreover, Professor Myres feels able to indicate, at least in outline, the course of events during that blank period which

succeeded the fall of Knossos and during which the culture of Mycenae was replaced by that of the "Dorians" outside Attica. Archaeology is thus at last joining hands with recorded history, lightening the darkness that has shrouded the rise of the early Greece that we know, and incidentally demonstrating that the "Iliad" and "Odyssey," like other great national epics, preserves a solid core of historic fact.

The Reclamation of Land from the Sea. By F. M. Du-Plat-Taylor. (Constable. 21s.).

The distinguished civil engineer whose "Design, Construction and Maintenance of Docks, Wharves and Piers" is a standard work deals in his new book with an allied problem of world-wide interest. He admits frankly and regretfully that the subject receives little attention in England nowadays because the value of agricultural land has fallen to such a degree that it is not worth while, financially speaking, to reclaim any land from the sea. He is able, however, to describe recent work done at Rye and on the lower Thames, at Southampton and on the Mersey, and he might have referred to the new Bromborough Dock scheme, just finished by Messrs. Lever Brothers after six years, as an example of the recovery of a useful site from a water-logged condition.

The greatest project of the kind is, of course, the reclamation of the Zuyder Zee, and to this magnificent undertaking, which reflects immense credit on the Dutch Government and people, the author devotes two very valuable and illuminating chapters. Later figures than those which the author has used show that the project is expected to result in a deficit of £16,000,000—on an estimated cost of £58,000,000—instead of about £8,000,000. But the author is surely right in concluding that "the scheme is justified as a work of national importance," since it will add half a million acres of fertile soil to overcrowded rural Holland and thus increase employment and benefit trade in many ways.

The technical description, fortified with plans and photographs, of this daring enterprise is admirably clear. It must be remembered that the Zuyder Zee dates only from the early Middle Ages, when the sea broke in and, as the land was slowly subsiding, gradually spread over more and more of the plain. Even so, the scheme of reclamation is truly magnificent.

Mr. Du-Plat-Taylor deals fully with the various aspects of reclamation—by enclosures, as in the Dutch case, and by filling, as at Bombay, Dublin and Rosyth—and describes the ingenious devices and the powerful plant which modern engineers use to foil the increasing attacks of the sea and to get rid of unwanted water. A brief closing chapter on "The Economic Scene" puts the financial side of the case and does not understate the cost of reclamation and upkeep.

The Romance of the British Museum. By W. H. Boulton. With a Foreword by Sir Frederic Kenyon. (Sampson Low. 12s. 6d.).

The attitude of the public to museums in general and the British Museum in particular has undergone a marked change in recent years, an indication of which is the fact that nearly a million and a quarter visitors entered the Museum in 1929.

If the attitude of the general public to the Museum has changed, the attitude of the Museum to the public has certainly done so too. When Montagu House was opened as the first British Museum in 1759 access was permitted only to a select number of ticket-holders: it was considered unsafe to allow the public to be admitted indiscriminately! According to the first book of rules, "such studious and curious persons" as desired to see the Museum were required to apply to the porter in writing, when their names were submitted to the principal librarian, who decided whether the applicants were "proper to be admitted." If they proved to be "proper," tickets were delivered to them by the porter. Not more than ten visitors were admitted at any one time, and they were permitted to spend one hour in each department; a bell warned them when their time had expired.

Interesting light on the relation of the British Museum to the public in 1818 is thrown in a speech by William Corbett in the House of Commons. Corbett, who referred to the Museum as "the old curiosity shop in Great Russell Street," asked of what use in the wide world was this British Museum. For his own part, he did not know where it was, but from the little he had heard, even if he did know he would not take the trouble of going to see it.

In later years, the history of the Museum has been one of steady and progressive service to the public. Great improvements have been made in the arrangement and description of the various sections, while the provision of capable guides to explain the exhibits proved a welcome innovation.

After outlining the growth of the Museum, the author briefly describes the various departments, referring to some of the principal exhibits. The book does not, of course, take the place of a guide, far less of the forty official handbooks now available. But it achieves a purpose for which a guide-book is not intended and is welcome as a popular introduction. It will do much to dispel the notion in the minds of those who are not acquainted with the National Collections that a visit to the British Museum is, to quote the author, "the dryest of all dry ways of spending a wet day." The book contains a hundred illustrations and an attractive coloured frontispiece reproduced from the Bedford Book of Hours.

The Green Leaf. The Major Activities of Plants in Sunlight. By D. T. MacDougal, M.S. (Appleton. 6s.).

"The Green Leaf" is a good title, and the author has written a good book which should bring home to readers who know little or nothing of biological science the fact that the continued existence of the organic world depends upon plants which possess the green colouring matter, chlorophyll. In the first chapter we are told that "a handful of soil, a cup of water and a fresh breeze furnish all the kinds of matter necessary for the growth of a bacillus, moss, tree, mouse or man." The truth of this statement is made clear in the succeeding chapters. It is no exaggeration to say that the green leaf is one of the most wonderful things in the world; we, in common with other animals, live on the food which green plants alone can manufacture from air and water with the mineral salts absorbed by roots from the soil. "The vegetable matter which enters into man's food includes not only the staples such as starch, sugar, oil, fibre and fatty substances, but also an indefinite number of accessory substances, of which the vitamins are an example."

The author adopts an ingenious method of elucidating the structure of a leaf and the methods of operation of the cells within it: he imagines a blade of grass enlarged at least one hundred thousand times and laid flat on the ground extending many miles across country. A man gains access to the interior of the factory through one of the millions of minute openings

on the surface and sees what he can of the processes by which gases, water and salts are " brought into a condition in which they may form the basis of life and the substances indispensable to his own existence."

The book is clearly written and is no mere popular exposition in which recent discoveries are ignored; it may confidently be recommended as a sound scientific introduction to a fascinating subject. It not only brings home to the layman our debt to green plants, but it illustrates methods of research and the fact that there is still much to be learnt from an intensive study of the " green leaf-mills."

Endurance: An Epic of Polar Adventure. By FRANK WORSLEY. (Philip Allan. 21*s*.).

Sir Ernest Shackleton's Antarctic voyage of 1914-16 is memorable for the courage with which he and his men faced and overcame misfortune. Commander Worsley, who was his skipper in the *Endurance*, has retold the story in a fine book which should become a classic of Polar adventure. The expedition had left England three days before war was declared on Germany and was beset in the Weddell Sea in the middle of 1915. Ice-pressure nipped the vessel and made her abandonment inevitable. After living for months on an ice-floe, the crew made their way in boats to Elephant Island. Thence Shackleton and Worsley with four of their men sailed in an open boat for sixteen days, in the depth of the Antarctic winter " over the worst seas in the world," to South Georgia and its whaling station.

Shackleton's own account of this desperate voyage is unforgettable, but his skipper's narrative is equally fascinating. When they reached South Georgia they had to climb the rugged mountains of the interior in order to reach the whaling station, but nothing could hinder these resolute men. A whaler lying there at once sailed for Elephant Island but failed to get within a hundred miles of it. A Uruguayan trawler and a British schooner were also unsuccessful. At last a small steamer lent by the Chilean Government got through the ice and the castaways on Elephant Island were rescued. In his closing pages he describes his last Antarctic voyage with Shackleton in 1921-22, and the death of his chief from heart failure while the ship was lying off South Georgia. This book, with its interesting photographs, is a valuable addition to our Antarctic literature.

Through the Caucasus to the Volga. By FRIDTJOF NANSEN. Translated by G. C. Wheeler. (Allen & Unwin. 12*s*. 6*d*.)

The late Dr. Nansen, among his many gifts, had the art of writing attractively. Thus his last book, although it deals mainly with so remote a subject as the little Soviet Republic of Daghestan, will be read with interest. On behalf of the League of Nations, he had visited Armenia in 1925—a journey which he described in his book on that country. On his way home he crossed the Caucasus, and spent some time in Daghestan, which lies on the west of the Caspian and is largely composed of barren mountains, forests, and swamps. The Lesghian hillmen, some half a million in all, are the main element in the population. They were the followers of the Moslem chief, Shamyl, who fought the Russian invaders for a quarter of a century (1834-59), and is a legendary hero of the Caucasus. There are two attractive chapters on the Lesghian fight for independence. Elsewhere the author gives a vivid picture of the wild mountains and fertile coast lands, and discusses the economic possibilities of the country. He came home by way of the Caspian to Astrakhan and up the Volga. The book is well illustrated with photographs, and deserves attention both for its subject and as the last work of a truly great man.

Alarms and Excursions in Arabia. By BERTRAM THOMAS. With a Preface by SIR ARNOLD T. WILSON. (Allen & Unwin. 15*s*.).

Mr. Bertram Thomas, who did good work in our Middle Eastern service and is now Prime Minister to the Sultan of Oman, has lately astonished geographers by making a fifty days' journey across the hitherto unknown Rub 'al Khali, the Great Sandy Desert of south-eastern Arabia. He had previously made two daring tours along the edge of that desert which he described in the *Geographical Journal*.

In his new book, which, like almost all books by English travellers in Arab countries, is extremely well written, he deals less with geography than with the human element which is really more important in the East as elsewhere. The first two sections describe his experiences as a district officer in Iraq, among the marsh Arabs of the lower Euphrates, in the spring of 1918 and again during the revolt of 1920. In the last three sections he deals with various journeys in and about the Sultanate of Oman, and gives a lively sketch of a little punitive expedition against an unruly chief on the coast to the north of Muscat, in which naval guns, with little harm to life, brought the scapegrace to terms.

Mr. Thomas has a happy way of picturing the daily life of the Southern Arabs; he recognizes the barbarity and greed of these primitive folk, whose interests are narrowly limited by the hard conditions of their life, and yet he likes them and evidently manages to win their respect and devotion, otherwise his dangerous desert journeys would have been impossible. No one interested in Arab problems should miss this excellent book.

The People of the Leaves. By VIVIAN MEIK. (Philip Allan. 12*s*. 6*d*.).

Scattered about India there are at least ten million " Animists "—pagan peoples of great antiquity and at varying stages of primitive culture. In this attractive book the author describes a pigmy race of forest dwellers whom he found in Northern Orissa—a province that contains many such waifs and strays. They are timid folk who live in the heart of the *säl* jungle. They have no clothes and do not make fires; their bows and arrows are mere toys; they cannot count; they lack any tribal organization and have no sexual taboos. Mr. Malinowski's Trobriand islanders are far in advance of these People of the Leaves.

Mr. Meik petted the children and made friends with the adults during a brief stay in the jungle. He witnessed a festival when the moon was at the full, begun with elaborate dances to the sound of the drum and ending with a drunken orgie, after the consumption of much herb beer. He also saw a funeral, with a ritual dance; the corpse, wrapped in leaves, was deposited in a tree. Clearly, then, even the Leaf People are a few steps up the long evolutionary ladder though they have not learned much since the Stone Age. The author is inclined to be sentimental, but he describes clearly what he saw, and the value of his book is considerably increased by his admirable photographs of these people and their dances.

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